PROBLEM GAMBLING: SUMMARIZING RESEARCH FINDINGS AND DEFINING NEW HORIZONS

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PROBLEM GAMBLING: SUMMARIZING RESEARCH FINDINGS AND DEFINING NEW HORIZONS

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EDITORIAL
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Editorial: Problem Gambling: Summarizing Research Findings and Defining New Horizons

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Editorial on the Research Topic

Problem Gambling: Summarizing Research Findings and Defining New Horizons

INTRODUCTION

More than a decade ago, Shaffer et al. (2006) reported that gambling-related research was growing at an exponential rate. Since that time, this trend appears to have continued, and much more is now known about this particular form of risky behavior. Nevertheless, there is still a general tendency to not perceive gambling as a potential danger for youth and other vulnerable populations.

The latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) included "gambling disorder" as the only condition in the section "non-substance-related disorders." Moreover, it was specified that this disorder can indeed occur in adolescence, young adulthood or even late adulthood. Despite this fact, theoretical and applied research on problem gambling especially with regard to adolescence and other risk groups still remains fragmentary. For this reason, we felt it to be important to organize a special research topic on gambling. The primary goals were to highlight the necessity of considering excessive gambling as a potential harmful activity, to summarize the state-of-art of international research on different aspects of the topic and to offer important novel findings relevant for advancing knowledge in the field of gambling. Taken together, the contributions can be classified into four broad categories: (1) youth gambling, (2) risk factors in adulthood, (3) measurement issues, and (4) clinical research.

OVERVIEW OF CONTRIBUTING PAPERS

In total, 18 papers are presented in this special issue. The first central domain refers to gambling among youth. Even though regulated forms of gambling are generally prohibited to minors, there is a considerable body of research that proves their involvement in gambling activities. A significant minority of adolescents even show gambling-related psychosocial problems (Calado et al., 2017). In addition, several studies have explored risk and protective factors in childhood, adolescence or young adulthood for the development of problem gambling symptoms (Dowling et al., 2017). Four papers in this issue have specifically focused on youth gambling, contributing to the current knowledge by exploring less studied psychosocial constructs or subpopulations and offering guidelines for the conception of interventions. From the broader social perspective, Canale et al. presented the first study with a large-scale nationally representative sample of adolescents to examine the effects of income inequality on adolescent gambling, concluding that wealth

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distribution may have an impact on youth gambling. Gender issues were raised with the study from Huic et al. focusing on gambling predictors of adolescent girls who are a much less studied population than boys. Furthermore, empirical findings from Nigro et al. with regard to different emotional and cognitive factors confirmed the impact of impulsivity and emotional distress on the development of youth problem gambling. Last but not least, Donati et al. addressed mindware problems (i.e., cognitive distortions) and their influence both on youth gambling as well as the conception of theoretically founded preventive interventions.

In addition, four papers shed light on specific risk constellations for the development and manifestation of gambling-related problems in adulthood. Based on representative data from Austria, Buth et al. tackled the question of whether certain risk factors are equally relevant for at-risk, problem, and disordered gamblers. Overall, their findings indicated that the included risk factors indeed differ between these gambling groups, suggesting the need for more tailored prevention and treatment strategies. In contrast to this approach, the study by Hing et al. aimed at identifying risk factors for three forms of problematic online gambling [i.e., electronic gaming machines (EGMs), sports betting, race betting]. While the risk profiles of online sports bettors and race bettors were largely similar, a rather different pattern emerged for online EGM gamblers pointing again to the importance of differential activities in terms of prevention and intervention. Unique findings also stem from Olason et al. who conducted a population-based follow-up study in order to determine the impact of the economic crisis in Iceland on gambling behavior. Interestingly, past year problematic gambling figures did not change after the economic collapse. However, an increased participation in lotto and scratch tickets indicates that gambling forms with low initial stakes and large jackpots may then become more enticing, in particular for individuals suffering financial difficulties. In a very well-balanced opinion paper Zakiniaeiz et al. finally recalled the necessity to study gender differences in gambling patterns, especially with regard to preferred gambling forms, the onset of disordered gambling, co-occurring disorders and disorder progression.

Another important area in gambling research relates to measurement issues. In particular, the reliable and valid assessment of problem gambling patterns has received a considerable amount of attention for both adolescents (Edgren et al., 2016) and adults (Pickering et al., 2018). Five papers deal with the psychometric properties of novel measurement tools. Against the background that large-scale prevalence studies consistently represent high prevalence rates of gambling participation among youth (see above), two papers directly focus on this age cohort. While Stinchfield et al. developed and evaluated the psychometric properties of the Brief Adolescent Gambling Screen (BAGS), a three-item screen for adolescent problem gambling, Donati et al. tested the gender invariance of their Gambling Behavior Scale for Adolescents (GBS-A) applying item response theory. New tools that broadly aim at determining risk and protective factors associated with problem gambling in adults were also introduced. For example, Barbaranelli et al. reported the psychometric properties of the Multidimensional Gambling Self-Efficacy Scale (MGSES), an innovative scale to measure self-efficacy as a protective factor for problem gambling. In addition, Cowie et al. provided preliminary evidence for the predictive validity of the Gambling Cognitions Inventory (GCI) as a measure of cognitive distortions, showing its relationship to several gambling outcomes over a 1-month and a 6-month time period, respectively. In a similar vein, Jonsson et al. assessed the capacity of the different dimensions of the Jonsson-Abbott Scale (JAS) to predict increases in problem gambling risk levels as well as the onset of problem gambling over 1 year.

The final main subject of interest relates to clinical examinations of problem gambling. Researchers and treatment providers have sought to identify the underlying issues associated with problem gambling and have tried to identify both the barriers preventing individuals for seeking help and best practices in working with individuals with this disorder. Five informative papers have looked at this issue from multiple perspectives. Challet-Bouju et al. provided a systematic review of cognitive interventions highlighting that this common form of intervention represents a promising approach to gambling disorder management while Tremblay et al. documented the experiences of gamblers and their partners either individually or in couple therapy. Their conclusion was that both forms of treatment were effective but more positive experiences emerged for couple therapy. In yet another interesting paper, Gavriel-Fried and Rabayov examined the importance of self-stigma for individuals seeking treatment for gambling, alcohol or other substance use problems. They summarized that stigma among individuals with gambling problems tend to work in a similar way as among those individuals with an alcohol or drug problem. Jiménez-Murcia et al. analyzed the frequency of the co-occurrence of gambling disorders and food addiction. Their findings suggest that almost 10% of individuals having a gambling disorder concurrently experienced a food addiction. In addition, a far higher ratio of food addiction was found in women. Lastly, Giroux et al. provided a systematic review of online and mobile interventions for problem gambling, alcohol and drug use. While this may prove promising in the future, more rigorous research is necessary before definite conclusions can be reached. In sum, more research is clearly needed in understanding gambling disorders or problem gambling patterns before best practice treatment approaches can be identified. Clinicians and treatment providers are well aware that problem gamblers do not represent a homogenous group (Blaszczynski and Nower, 2002) and that differential approaches may be required.

Overall, 94 different authors from 15 countries contributed to this special issue. We remain confident that these 18 papers significantly add to the understanding of problem gambling and will further stimulate high-quality gambling research in its many facets.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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ORIGINAL RESEARCH
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Income Inequality and Adolescent Gambling Severity: Findings from a Large-Scale Italian Representative Survey

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Background: Studies have shown that problems related to adult gambling have a geographical and social gradient. For instance, adults experiencing gambling-related harms live in areas of greater deprivation; are unemployed, and have lower income. However, little is known about the impact of socioeconomic inequalities on adolescent problem gambling. The main purpose of the present study was to investigate the contextual influences of income inequality on at-risk or problem gambling (ARPG) in a large-scale nationally representative sample of Italian adolescents. A secondary aim was to analyze the association between perceived social support (from family, peers, teachers, and classmates) and ARPG.

Methods: Data from the 2013–2014 Health Behavior in School-aged Children Survey (HBSC) Study was used for cross-sectional analyses of ARPG. A total of 20,791 15-year-old students completed self-administered questionnaires. Region-level data on income inequality (GINI index) and overall wealth (GDP per capita) were retrieved from the National Institute of Statistics (Istat). The data were analyzed using the multi-level logistic regression analysis, with students at the first level and regions at the second level.

Results: The study demonstrated a North–South gradient for the prevalence of ARPG, with higher prevalence of ARPG in the Southern/Islands/Central Regions (e.g., 11% in Sicily) than in Northern Italy (e.g., 2% in Aosta Valley). Students in regions of high-income inequality were significantly more likely than those in regions of low-income inequality to be at-risk or problem gamblers (following adjustment for sex, family structure, family affluence, perceived social support, and regionale wealth). Additionally, perceived social support from parents and teachers were negatively related to ARPG.

Conclusions: Income inequality may have a contextual influence on ARPG. More specifically, living in regions of highest income inequality appeared to be a potential factor that increases the likelihood of becoming an at-risk or problem gambler. Findings of the study suggest that wealth distribution within societies affected by economic policies may indirectly have an influence adolescent gambling behaviors.

Keywords: gambling, adolescent gambling, youth gambling, problem gambling, inequality, representative survey

INTRODUCTION

Gambling disorder is a recognized mental health condition that comprises persistent and recurrent problem gambling causing individuals significant psychological impairment and/or distress (American Psychiatric Association, 2013). Furthermore, in many countries, problem gambling among adolescents has emerged as an increasing social and public health issue (Volberg et al., 2010; Molinaro et al., 2014; Calado et al., 2016) including the country of the present study (i.e., Italy). Despite Italian legislation prohibiting minors from participating in legalized gambling, previous research has shown that youth gambling is a popular activity in Italy. For instance, results from the European-School-Survey-Project-on-Alcohol-and-Other-Drugs (ESPAD-Italia®), conducted annually on representative sample of students 15–19 year-olds, showed that during 2012, 18% of students gambled at least once a month on one or two gambling activities (frequent gamblers; Canale et al., 2016b) and during 2013, 6.5% were classified as problem gamblers (Canale et al., 2016a).

Additionally, an analysis of the ESPAD-Italia®2011 data showed that the prevalence of at-risk/problem gambling was higher for adolescents living in more disadvantaged regions (Gori et al., 2015), suggesting that problem gambling can also be considered a social problem (Reith and Dobbie, 2011). Although, Gori et al. (2015) used socio-cultural indicators such as the (i) unemployment rate, (ii) non-engagement rate in Education, Employment or Training (NEET), and (iii) part of per capita GDP expended in gambling activities, it did not focus on structural determinants of adolescent health, for example national wealth or income inequality (e.g., Dorling et al., 2007; Viner et al., 2012). Recently, socioeconomic inequality has shown to have an increasing impact on adolescent health (e.g., Elgar et al., 2015). Additionally, structural determinants of adolescent health (e.g., health expenditure) have been associated with lower levels of probable gambling problems among representative samples of students living in nine European countries (Albania, Cyprus, Denmark, Finland, Italy, Lithuania, Romania, Serbia, and the United Kingdom; Molinaro et al., 2014). However, to date, no studies have investigated the association between structural determinants of adolescent health, such as socioeconomic inequality, and adolescent problem gambling in general, and specifically in Italy, a country characterized by large and rising levels of inequality and poverty. Over the last thirty years, Italy has seen an increase in income inequalities. According to the 2015 Luxembourg Income Study, Italy registered some increase (0.05 to 0.1 point per year) in the Gini Index from 1980 to 2010 (Thewissen et al., 2015). The levels of income inequality have been magnified by the economic crisis and are reflected by regional differences, with the more disadvantaged areas also being the more unequal (The World Top Incomes Database, 2011). Thus, the present study examined the association between structural determinants of adolescent health (i.e., regional income inequality and GDP) and problem gambling in Italy, a country characterized by rising levels of inequality and poverty (Thewissen et al., 2015).

Problem gambling is governed by a complex set of interrelating factors, causes, and determinants ranging from biology and family history to social norms and existing statutes (Messerlian and Derevensky, 2005; Abbott et al., 2013). Consequently, many factors may come into play in various ways and at different levels that together contribute to the development and maintenance of gambling-related problems (e.g., biological, psychological, or social). According to the conceptual framework for the development of gambling in youth (Barnes et al., 1999) and the conceptual framework of harmful gambling (Abbott et al., 2013), broader perspectives are important when considering problem gambling, including both contextual macro-level factors (social, economic, and political forces) and interpersonal factors (e.g., support from parents, friends). Thus, the present study provides new insight into the possible combination of interpersonal and macro-level factors in explaining the development of adolescent gambling severity.

Socioeconomic Inequalities in Adolescent Health: The Case of Adolescent Gambling

Within contextual factors, there is an association between societal inequality and many different negative health and social outcomes, such as sexual promiscuity, teenage pregnancy, violence, substance abuse, crime, psychological and physical disorders, and life satisfaction (see Pickett and Wilkinson, 2015 for a recent review; Elgar et al., 2015). On the other hand, the distribution of gambling problems reflects the geographic distribution of socioeconomic deprivation (Reith, 2012). For instance, in Australia, the greater the socioeconomic disadvantage of a municipality, the higher its numbers of gambling opportunities (e.g., gaming machines), with people living in areas of high deprivation spending close to twice as much the state's mean expenditure on slot machines (Livingstone, 2001). Problem gambling also has a social and geographical gradient. For instance, adults experiencing gambling-related harm (i) live in areas of greater deprivation, (ii) are unemployed, and (iii) have lower income (Orford et al., 2010; Wardle et al., 2014). A growing body of laboratory studies suggests that people who feel relatively deprived have more severe gambling problems (Callan et al., 2008; Haisley et al., 2008; Mishra and Novakowski, 2016; Tabri et al., 2017). Consistent with the risk-sensitivity theory (Caraco et al., 1980), victims of income inequality engage in greater risk-taking behaviors (Mishra et al., 2014) because inequality facilitates the perception of need in that victims of inequality are at distance from the desired or goal state or more privileged others.

Although there is great empirical evidence of an inequality-risk association at the societal level, unexpectedly little research has studied whether inequality at societal level is associated with adolescent gambling. Inequality, more specifically income inequality, might be associated with adolescent gambling because income inequality is responsible for an intensification of societal class competition, that when compared to more egalitarian societies, makes status increasingly important for survival (Wilkinson, 2004; Wilkinson and Pickett, 2009). Status competition in more hierarchical societies increases because greater numbers of people are deprived access to success and status markers (Wilkinson and Pickett, 2009). Among minors,

who are acutely aware of class differences, inequality in income might increase the social distance between such individuals who live in the same society fostering a tough social environment that regularly features acts of rejection, teasing, and humiliation (Elgar et al., 2009).

Income inequality intensifies perceptions that an individual is unjustly resource disadvantaged relative to others. Such relative deprivation is accompanied by feelings of anger and resentment (Crosby, 1976; Smith et al., 2012) that motivates a desire to move up the social ladder, especially individuals lower down the income distribution (Wilkinson and Pickett, 2009). Thus, it possible that when individuals perceive themselves as unfairly deprived they may also engage in maladaptive behaviors to advance their financial position. For example, individuals who feel relatively deprived are apt to gamble in an attempt to quickly reduce their perceived financial disadvantage (see Callan et al., 2015 for a meta-analysis). More recently, Tabri et al. (2017) showed that relative deprivation is most likely to lead to disordered gambling when individuals perceived a low personal capacity for upward economic mobility via conventional means (e.g., professional development activities). In this context, gambling may be considered by adolescents as a means: (i) to help people meet their needs and wants and/or offset feelings of deprivation through the possibility of financial windfall (Mishra et al., 2017); and/or (ii) to be a path to upward economic mobility (Tabri et al., 2015). Thus, the principal aim of the present study was to verify the association between income inequality and adolescent problem gambling at a societal level (regions).

Social Support and Gambling

Social support has been cited as a protective factor against a wide range of risk behaviors, including adolescent problem gambling. Social support provided by individuals and institutions is defined as interpersonal relationships that are able to influence the way in which individuals live. Supportive relationships with others (i.e., social support) have been conceptualized as resources that promote successful adaptation during adolescence (Compas et al., 1995; Juang and Silbereisen, 1999; Saunders et al., 2004; Moor et al., 2015). During adolescence, there are several potential sources of social support (e.g., parents, siblings, friends, classmates, and teachers) and they are sensitive to the interconnections between these sources (Benhorin and McMahon, 2008). Examples of social support include parent's closeness, monitoring and caring, teachers' interest in their students, and friends' supportiveness (Jessor et al., 2003). Perceived social support is frequently used in the study of adolescent development as a proxy for good social support (Wills and Shinar, 2000). Such support denotes the perceived extent by people to which individuals within their social networks can provide social support (Demaray and Malecki, 2002). High social support may protect against gambling-related harms by promoting social environments whereby adolescents feel accepted and wanted without teasing, rejection, and humiliation related to social comparisons (e.g., reducing status competition within society).

Previous studies have found that social support from school, parents, and friends all influence adolescent problem gambling. For example, non-gamblers and social gamblers perceive they have more social support from parents and friends (e.g., having parents and peers who provided support and encouragement) than at-risk and problem gamblers (Hardoon et al., 2004; Molinaro et al., 2014; Canale et al., 2017). Similarly, high forms of social support from school and teachers have shown to be protective against gambling participation among 14–16-year-old Finnish adolescents (Räsänen et al., 2016). More specifically, it was found that having teachers who provided support and encouragement within a supporting schools setting (e.g., schools helping students when they need it) reduced the odds of being engaged in gambling activities (Räsänen et al., 2016). It appears that supportive families, supportive schools, together with supportive peers, are crucial in protecting adolescents from gambling-related harms. These social relationships, that have been found to differ between the most and least unequal regions (De Clercq et al., 2016; Ng Fat et al., 2016), might also moderate the influence of inequality act on adolescent gambling severity. Indeed, the lack of social support might exacerbate the impact of income inequality on adolescent problem gambling. Thus, the present study intended to clarify the additive role of social support and macro-level factors related to adolescent gambling severity.

The Present Study

Consistent with the literature reviewed, the principal aim of the present study was to establish the relationships between at-risk or problem gambling (ARPG) and income inequality. It is hypothesized that in regions with higher levels of income inequalities, adolescents would report higher levels of ARPG compared to more egalitarian regions. A secondary aim was to analyze the association between perceived social support (from family, peers, teachers, and classmates) and ARPG. It was also hypothesized that adolescents who perceived more social support would be less likely to report higher levels of ARPG than those who perceived less social support. Finally, another aim of the present study was to explore possible interactions between perceived social support and region-level inequality in influencing problem gambling. It was hypothesized that the impact of living in a more unequal region on ARPG would be stronger for adolescents perceiving lower levels of social support.

METHODS

Participants

The data were collected in the Italian 2013–2014 Health Behavior in School-aged Children (HBSC) survey. An aim of the HBSC study (see http://www.hbsc.org for more details) was to identify behaviors and social factors that influence behavioral addictions (including ARPG) in youth. In Italy, students from Grade 6 (11-year olds) to Grade 10 (15-year olds) secondary schools were invited to participate. Because assessments of gambling were only included in the 15-year-olds'questionnaires, 11- and 13-year-old students were excluded from the present study. The sample comprised 20,791 students (male, 50.3%) nested within 1,050 schools and 21 Italian regions/cities (Abruzzo, Aosta

Valley, Basilicata, Calabria, Campania, Emilia-Romagna, Friuli Venezia Giulia, Latium, Liguria, Lombardy, Marches, Molise, Piedmont, Puglia, Sicily, Sardinia, Trentino, Tuscany, Umbria, and Veneto)[1]. A random sample of schools was drawn from the National School Office. The average participation rate by students was 91%. Nationally representative samples of students in Grade 10 participated in the present study. The self-completion questionnaires were administered by classroom teachers during normal school day classes. The questionnaire took ∼50 min to complete. Written informed consent was obtained from the parents of the students of this study and all participants were assured of the confidentiality of their responses. The University of Turin's Ethics Committee granted ethical approval for the study.

Measures

The current study comprises a secondary data analysis of the Italian HBSC 2013–2014 survey which includes questions related to a number of different behaviors. The reliability and validity of these scales assessing such behaviors among teenagers in various countries is well-established (Lazzeri et al., 2013).

Dependent Variable

At-risk or problem gambling (ARPG) was assessed with the 12-item South Oaks Gambling Screen-Revised for Adolescents SOGS-RA (Italian version: Chiesi et al., 2013). Participants were presented with 12 items assessing negative consequences associated with gambling behavior over a past-year timeframe on a binary "yes-no" scale scored 1 or 0, respectively. The original scoring system of Winters et al. (1995) was used to estimate prevalence rates of ARPG during the past 12 months. The scoring was as follows: 0–1 = "no gambling problem," 2–3 = "at-risk gambling," and 4 or more = "problem gambling." In previous studies, ARPG has been considered as part of a wider spectrum of problematic adolescent gambling (Potenza et al., 2011). Consistent with previously used groups, they were dichotomized into "at-risk-problematic gamblers" and "non-problematic gamblers" (Wickwire et al., 2007; Potenza et al., 2011). The instrument had adequate internal reliability ($\alpha = 0.78$; 95% CI = 0.78–0.80). In a recent systematic review, Edgren et al. (2016) found that most studies examining adolescent gambling used the SOGS-RA as the primary ARPG instrument. In addition, items on frequency of gambling involvement (in their lifetime and in the last 30 days) were also included, as well as the number of gambling occasions ("During the last 30 days/In your lifetime, on how many occasions [if any] have you participated in gambling activities?"—seven options ranging from "never" to "30 or more days"). A binary variable was created describing the gambling lifetime frequency (0 = never; 1 = from "1–2 days" to "30 or more days").

[1]All Italian regions were involved, but the Trentino Region provided data for only two cities: Bolzano and Trento. Thus, the present study shows data for 19 regions (Abruzzo, Aosta Valley, Basilicata, Calabria, Campania, Emilia-Romagna, Friuli Venezia Giulia, Latium, Liguria, Lombardy, Marches, Molise, Piedmont, Puglia, Sicily, Sardinia, Tuscany, Umbria, and Veneto) and two cities (Bolzano and Trento).

Individual-Level Variables

Family structure

Family structure was assessed utilizing responses to the single question "Which of the following people live in the same household with you?" to indicate students who lived with two biological or adoptive parents or those that lived in other types of family set-up (e.g., single-parent families; Hamilton et al., 2014).

Family wealth

Family wealth was assessed using the Family Affluence Scale (FAS) (Boyce et al., 2006). The FAS refers to familial (material) wealth by asking questions relating to number of family holidays over the past 12 months, the number of household cars, the number of home computers in the house, and whether participants had a bedroom of their own. Scores ranged from zero to seven and were divided into three groups. Students scoring between zero and four were placed into the "low-affluence" category, those scoring between five and six were placed into the "moderate-affluence" group, and those who scored seven were placed in the "high-affluence" category. Previous studies indicated that compared to other family affluence measures relying on parental occupation, education and/or income, the FAS has superior criterion validity and is much less affected by nonresponse bias (Boyce et al., 2006; Currie et al., 2008). Social support was measured using a perceived support definition of social support with the following four sources of support: teachers, classmates, parents, and friends.

Perceived classmate support

Perceived classmate support was assessed with three items from the Teacher and Classmate Support Scale (Torsheim et al., 2000): "The students in my class enjoy being together," "Most of the students in my class are kind and helpful," and "Other students accept me as I am." Items were rated on a 5-point frequency scale from (1) "strongly agree" to (5) "strongly disagree." Responses were reverse coded and then the three items were averaged. Higher scores indicate a higher level of perceived support from classmates. Alpha reliability for the 3-item scale was 0.76 (95% CI = 0.75–0.77).

Perceived teacher support

Perceived teacher support was assessed using three items: "I feel my teacher accepts me as I am," "I feel that my teachers care about me as a person" and "I feel a lot of trust in my teachers" (e.g., Klemera et al., 2016; Bjereld et al., 2017). Alpha reliability for the 3-item scale was 0.79 (95% CI = 0.78–0.80). Higher scores indicate a higher level of perceived support from teachers.

Perceived friend support

Perceived friend support was assessed using four items from a sub-scale of the Multidimensional Scale of Perceived Social Support (Zimet et al., 1988): "My friends really try to help me," "I can count on my friends when things go wrong," "I have friends with whom I can share my joys and sorrows" and "I can talk about my problems with my friends." Items were rated on a 7-point frequency scale from (1) "strongly disagree" to (7) "strongly disagree." Alpha reliability for the 4-item scale was 0.90 (95%

CI = 0.89–0.91). Responses were averaged in order to assess perceived friend support.

Perceived family support

Perceived family support was assessed by four items from a subscale of the Multidimensional Scale of Perceived Social Support (Zimet et al., 1988): "My family really tries to help me," "I get the emotional help and support I need from my family," "I can talk about my problems with my family" and "My family is willing to help me make decisions." Items were rated on a 7-point frequency scale from (1) "strongly disagree" to (7) "strongly disagree." Alpha reliability for the 4-item scale was 0.89 (95% CI = 0.89–0.90). Responses were averaged in order to assess perceived family support.

Regional-Level Variables

Data on Italian regional wealth (gross domestic product [GDP] per capita) and income inequality (Gini index) were taken from the National Institute of Statistics (ISTAT, see www.istat.it). These data are presented in **Table 1**. The Gini index denotes the distribution of income or consumption among citizens in a society, and ranges theoretically from 0 (where all persons have equal income; perfect equality) to 1 (where one person has all the income and the rest have none; perfect inequality). With the aim of facilitating logistic regression analysis, regions were grouped into approximate thirds of low, medium, and high income inequality based on Gini indices (e.g., Elgar et al., 2005), as presented in **Table 1**.

Data Analysis

Prevalence of ARPG was compared by gender using a χ^2 test. For the χ^2 test, the phi (Φ) coefficient is reported, where values between −0.3 and +0.3 are treated as trivial associations. Hierarchical Linear Modeling (HLM) software version 7 (Raudenbush et al., 2011) was used to test multilevel logistic regression models of the effects of income inequality on ARPG. Multilevel statistical models are parametric models varying at more than one level. These are especially useful for research designs in which data are operationalized across more than one level (in the present study's case, individuals were nested within regions). Hierarchical linear models permit variance and covariance components to be partitioned across levels as well as the modeling of such variance by the inclusion of multilevel predictors (e.g., Molinaro et al., 2014; Vieno et al., 2015, 2016).

Due to the dichotomous nature of the dependent variable ARPG (yes/no), the models were analyzed with hierarchical generalized linear model (HGLM) using a Bernoulli sampling

TABLE 1 | Descriptive statistics for the Italian regional variables: Data provided for regions/cities (n = 21)[#].

Country	*n*	Gini index	GDP per capita	At-risk or problem gambling % (n)					Gambling frequency%(*n*)—lifetime prevalence				
				Total	Boys	Girls	χ^2	Φ	Total	Boys	Girls	χ^2	Φ
LOW INCOME INEQUALITY													
Aosta Valley	521	0.246	37.00	2.0 (11)	4.0 (8)	1.0 (3)	3.93*	0.09	29.0 (150)	46.0 (105)	15.0 (45)	57.65***	0.33
Bolzano	729	0.260	39.90	2.0 (13)	3.0 (10)	1.0 (3)	6.9**	0.10	41.0 (299)	48.0 (145)	36.0 (154)	10.86**	0.12
Friuli Venezia Giulia	1,005	0.260	27.90	5.0 (46)	7.0 (37)	2.0 (9)	11.44**	0.11	33.0 (331)	44.0 (248)	19.0 (83)	73.02***	0.27
Trento	796	0.270	33.90	2.0 (16)	3.0 (12)	1.0 (4)	4.00*	0.07	28.0 (224)	36.0 (144)	20.0 (80)	25.95***	0.18
Veneto	2,447	0.270	30.00	4.0 (89)	6.0 (63)	2.0 (26)	17.68***	0.09	30.5 (744)	45.0 (530)	17.0 (214)	224.59***	0.30
MEDIUM INCOME INEQUALITY													
Abruzzo	737	0.300	23.10	11.0 (75)	18.0 (64)	3.0 (11)	39.95***	0.24	44.0 (321)	66.0 (245)	21.0 (76)	150.68***	0.46
Basilicata	576	0.280	18.70	9.0 (43)	16.0 (39)	2.0 (4)	32.23***	0.25	41.0 (231)	63.0 (176)	19.0 (55)	117.79***	0.45
Emilia-Romagna	1,116	0.290	32.50	6.0 (64)	10.0 (56)	2.0 (8)	30.22***	0.17	35.0 (390)	48.5 (293)	19.0 (97)	106.02***	0.31
Lombardy	1,474	0.300	35.00	5.0 (75)	9.0 (65)	2.0 (10)	37.01***	0.16	44.0 (653)	58.0 (445)	30.0 (208)	117.00***	0.29
Marche	978	0.280	25.20	5.0 (50)	11.0 (43)	1.0 (7)	41.48***	0.21	39.0 (379)	58.0 (241)	25.0 (138)	112.85***	0.34
Molise	845	0.290	20.30	9.0 (71)	15.0 (61)	3.0 (10)	34.99***	0.21	38.0 (319)	59.0 (262)	14.0 (57)	174.55***	0.45
Piedmont	1,004	0.286	27.80	6.0 (53)	9.0 (43)	2.0 (10)	21.70***	0.15	33.0 (332)	49.0 (242)	18.0 (90)	108.79***	0.33
Puglia	1,070	0.310	16.90	9.0 (89)	15.0 (77)	2.0 (12)	47.42***	0.22	40.0 (426)	56.0 (306)	23.0 (120)	119.80***	0.34
Tuscany	1,030	0.280	28.90	3.0 (26)	5.0 (23)	1 (3)	17.84***	0.14	32.0 (331)	49.0 (240)	17.0 (91)	115.07***	0.34
Umbria	1,065	0.300	23.90	5.0 (46)	7.0 (40)	1.0 (6)	20.63***	0.14	38.0 (404)	56.0 (319)	17.0 (85)	167.70***	0.40
HIGH INCOME INEQUALITY													
Latium	955	0.350	31.70	7.0 (63)	11.0 (56)	2.0 (7)	33.95***	0.19	41.0 (387)	56.0 (285)	23.0 (102)	112.17***	0.34
Liguria	1,087	0.320	29.00	5.0 (51)	8.0 (40)	2.0 (11)	19.26***	0.14	33.0 (355)	48.0 (253)	18.0 (102)	106.37***	0.31
Campania	841	0.350	16.80	9.0 (72)	14.0 (60)	3.0 (12)	25.74***	0.18	48.0 (400)	72.0 (328)	19.0 (72)	240.60***	0.54
Calabria	883	0.320	16.20	10.0 (81)	16.0 (68)	3.0 (13)	37.70***	0.22	46.0 (404)	65.0 (299)	25.0 (105)	137.53***	0.40
Sicily	843	0.360	17.00	11.0 (84)	19.0 (77)	2.0 (7)	59.02***	0.28	43.5 (365)	66.0 (288)	19.0 (77)	189.44***	0.48
Sardinia	789	0.320	19.80	6.0 (40)	9.0 (32)	2.0 (8)	17.51**	0.15	33.0 (261)	51.0 (194)	17.0 (67)	104.02***	0.37

$^{***}p<0.001$; $^{**}p<0.01$; $^{*}p<0.05$; $^{\#}$*The number of regional levels totals 21 because the Trentino data comprised two different geographic areas (i.e., Bolzano and Trento).*

model with the following logit link function:

$$\eta_{ijk} = log[\Phi_{ijk}/(1 - \Phi_{ijk})] \quad (1)$$

where η_{ijk} is the log of the odds of being in the group reporting gambling and Φ_{ijk} is the probability of being member of this group. The initial analyses comprised an estimation of the unconditional model, where γ_{00} represented the average log-odds of being in the group of gamblers from the 21 Italian regions/cities taken into account. Next, the analysis involved simultaneously fitting two regression models for the dependent variable: a within-region model and a between-regions model. The within-region (Level 1), between individual-level variables and ARPG was examined (Model 1) for student i in region j, via the following equation:

$\eta_{ijk} = \pi_{0j} + \pi_{1j}(\text{Male}_{ij}) + \pi_{2j}(\text{Family Wealth}_{ij}) + \pi_{3j}(\text{Other Family Types}_{ij}) + \pi_{4j}(\text{Perceived Family support}_{ij}) + \pi_{5j}(\text{Perceived Peer support}_{ij}) + \pi_{6j}(\text{Perceived Teacher support.}_{ij}) + \pi_{7j}(\text{Perceived Classmate support}_{ij}) + e_{ij}$

where η_{ij} is the log of the odds of being in the group of gamblers, π_{0j} is the intercept, π_{1-7j} are the parameters of the slopes for individual predictors, and e_{ij} is the level-1 error term. The between- region (Level 2) model estimated the influence of the GINI index and per capita GDP (at the regional level, Model 2) exerted on students' ARPG:

$$\pi_{0j} = \beta_{00} + \beta_{01}(GINI_j) + \beta_{02}(GDP_j) + r_{0j} \quad (2)$$

Each of the Level-2 predictors were grand mean centered, and all the Level 1 slopes were controlled for their variations (i.e., free to have different effect across region).

RESULTS

Among the nationally representative sample of Italian adolescents, the lifetime prevalence of gambling was 37.0%. Boys showed higher rates of lifetime gambling involvement compared to girls in each region (see **Table 1**). The reported levels of ARPG are 6.0% (total sample prevalence) with boys reporting higher levels of ARPG (10%) than girls (2%). In particular, the present study demonstrated a North–South gradient for the prevalence of ARPG, with higher prevalence of ARPG in the Southern/Islands/Central Regions (e.g., 11% in Sicily) than in Northern Italy (2% in Valle d'Aosta; **Figure 1**). With regard to gender distribution for each region, at-risk and problem gamblers were more likely to be male and less likely to be female (see **Table 1**).

Table 2 reports the means, standard deviations, and bivariate correlations for the individual and regional variables. With regard to the social support, students reported receiving more support from peers ($M = 5.86$; $SD = 1.47$) than from the family ($M = 5.76$; $SD = 1.54$); and from classmates ($M = 3.78$; $SD = 0.81$) than from teachers ($M = 3.37$; $SD = 0.81$). All bivariate correlations among study variables (at the individual and regional level) were in the hypothesized direction.

The HLM models are reported in **Table 3**. The first step in HLM involved fitting an unconditional model (empty model)

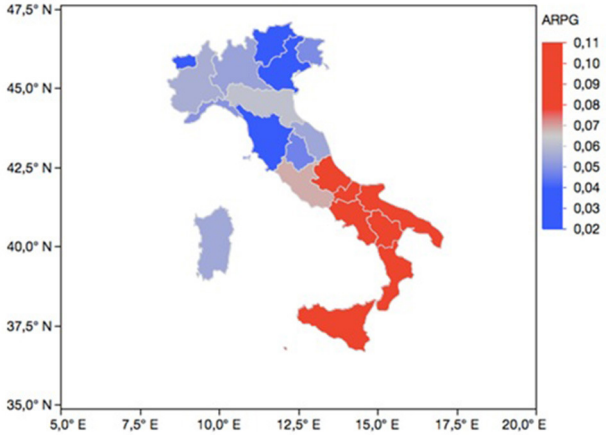

FIGURE 1 | Regional prevalence of ARPG in 15-year-old Italian students (n = 20,791). ARPG (at-risk or problem gambling); Data reported for Trentino-Alto Adige region are the mean between two different geographic areas (Trento and Bolzano).

and comparing the empty model at one level (individuals) with the empty model at two levels (regions). The population-average estimate γ_{00} represented the average logs odds of ARPG in a region ($\gamma_{00} = -2.812$). This means that for a region with a random effect $u_{00} = 0$, the expected odds of being in the ARPG group was 0.094. Given the estimate of $\tau_{00} = 0.263$ at the regional level, it was expected that 95% of the region would have log odds between −3.817 and −1.807, corresponding to a probability of reporting ARPG between 2.1 and 14.3%. The reliability for the unconditional model was 0.915 at the regional level.

The within-region model (Model 1) included individual variables. In the total sample model, males were more likely to be at-risk or problem gamblers. Adolescents not living with two biological or adoptive parents were significantly more likely to be ARPGs than adolescents living with two biological or adoptive parents. Additionally, adolescents who lived in more affluent families were significantly less likely to be ARPGs than those in a lower FAS family. With regard to social support variables, students who perceived more parental support reported less involvement in ARPG. Moreover, students who perceived stronger teacher support were less likely to be ARPGs. Finally, there were no associations between ARPG and perceived support from peers and classmates.

The between-region model (Model 2) included regional variables. In the 21 Italian regions/cities, income inequality (Gini index) was positively associated with ARPG. Thus, students who lived in a region/city with more pronounced income inequalities had higher odds of ARPG. Additionally, GDP per capita was negatively related to ARPG. Students who lived in a region/city in which GDP per capita was higher were less likely to be ARPGs. Additionally, in order to verify the possible different effects of perceived social support among adolescents living in different regions/cities, parallel analyses were performed by verifying the variability of these effects. A significant variability was only observed for perceived teacher support ($X^2 = 36.588$, $p < 0.05$).

TABLE 2 | Between individual- and regional-level variables: Descriptive statistics and correlations.

	1	2	3	4	5	6	7	8	Mean (*SD*)	Minimum-maximum
INDIVIDUAL LEVEL (*N* = 20,791)										
1. Gender (male)	–								0.50 (0.50)	0.0–1.0
2. Family Wealth	0.04***	–							2.01 (0.66)	1.0–3.0
3. Other Family Types	0.07***	−0.05***	–						0.29 (0.45)	0.0–1.0
4. Perceived Family support	0.12***	0.06**	−0.07***	–					5.76 (1.55)	1.0–7.0
5. Perceived Peer support	−0.08***	0.05***	−0.05***	0.30***	–				5.86 (1.47)	1.0–7.0
6. Perceived Teacher support	0.04***	−0.01	−0.04***	0.28***	0.123***	–			3.37 (0.81)	1.0–5.0
7. Perceived Classmate support	0.13***	0.04***	−0.03***	0.23**	0.29***	0.27***	–		3.78 (0.81)	1.0–5.0
8. ARPG	0.18***	−0.04**	0.06***	−0.05***	−0.05**	−0.04***	−0.02**	–	0.06 (0.23)	0.0–1.0
REGIONAL LEVEL (*N* = 21)#										
1. GINI	–								2.04 (0.74)	1.0–3.0
2. GDP per capita	−0.60**	–							26.26 (7.52)	16.20–39.90
3. ARPG	0.62**	−0.81***	–						0.06 (0.03)	0.01–0.11

*** $p < 0.001$; ** $p < 0.01$; # *The number of regional levels totals 21 because the Trentino data comprised two different geographic areas (i.e., Bolzano and Trento).*

However, none of the regional level predictors explained this variability.

DISCUSSION

The primary aim of the present study was to extend knowledge of adolescent gambling research by examining the association between structural determinants of adolescent gambling in a representative sample of adolescent students living in Italy. Three main results emerged from the data analysis. First, the results demonstrated that there was a North–South gradient for the prevalence of at-risk and problem gambling (ARPG) in Italy, with higher prevalence of at ARPG in the Southern/Islands/Central Regions (11% in Sicily/Abruzzo) than in Northern Italy (e.g., 2% in Valle d'Aosta). This result is partially consistent with previous reports showing that the prevalence of ARPG is higher for adolescents living in more disadvantaged regions in Italy (Gori et al., 2015). However, the present study provides, for the first time to the present authors' knowledge, demonstration of an association between income inequality and adolescent ARPG. More specifically, regional income inequalities (using GINI values) were positively related to ARPG. Thus, adolescent students who live in more unequal regions have a higher probability of being at-risk and problem gamblers (ARPGs). It is possible that larger income differences may increase gambling severity by increasing social status differences, status insecurities, competition and concerns about one's relative position in the social hierarchy (Wilkinson, 2004; Wilkinson and Pickett, 2009). These concerns start to become salient when adolescents are still developing a coherent understanding of social and economic hierarchies and their place in them (Yates and Youniss, 1999; Quintana, 1999). Adolescence is also a particularly sensitive developmental period characterized by a shift in the type of status that matters for adolescents, with their own money and position within the peer group begin to gain greater importance (i.e., adolescents start developing their own status positions).

According to risk sensitivity theory (i.e., Mishra et al., 2017), in more unequal regions, adolescents who experience disparities between one's present and desired outcomes would prefer relatively higher risk options, such as gambling. They may believe that in conditions of difficulty in satisfying a perceived need (i.e., money), greater risk-taking (e.g., involvement in gambling activities) is a way to satisfy such a need (Weber et al., 2004; Mishra and Fiddick, 2012). According to relative deprivation theories (Crosby, 1976; Walker and Smith, 2002), for such adolescents, gambling can be seen as a justice-seeking occupation (Callan et al., 2008) because gambling might offer resources to pursuing desirable outcomes (e.g., money, peer status) that adolescents might feel they merit but are otherwise unwilling or unable to reach via conventional means (e.g., having a job). In fact, gambling is seen as a means for monetary gain (Dechant and Ellery, 2011; Canale et al., 2015a; Devos et al., 2016), especially if traditional ways of making money are blocked and/or unavailable (Tabri et al., 2015). These potential explanations support contemporary theories of poverty, suggesting that what matters in affluent societies is the capacity to live life on a par with others (Sen, 1983; Townsend, 1979).

Additionally, adolescents living in more deprived contexts may be more prone to gamble because they believe that their self-worth is enhanced via gambling-related wins (Turner et al., 2002; Morasco et al., 2007) or may turn to gambling when they believe that economic mobility via traditional avenues is unlikely (Tabri et al., 2015). When this belief occurs, gambling can be used as a means to relieve their relative deprivation experience. Moreover, an additional explanation of why income inequality appears to increase ARPG might involve the disadvantage hypothesis, whereby stress arising from living in more unequal areas leads individuals to use substances as a coping mechanism (Caldwell et al., 2008). The distress that stems from living in unequal societies where individuals can feel angry and resentful when they believe that they have less than they deserve compared to others (for a review, see Smith et al., 2012), may drive them to gamble to cope with negative affect or to enhance positive affect.

TABLE 3 | Odds ratios (95% CI) for reporting at-risk or problem gambling in relation to individual and regional variables.

	Empty model	Model 1	Model 2
FIXED EFFECT			
Intercept	0.06 (0.05–0.07)***	0.02 (0.01–0.03)***	0.02 (0.01–0.03)***
INDIVIDUAL LEVEL (*N* = 20,791)			
Males (reference = females)		6.43 (5.40–7.66)***	6.51 (5.44–7.80)***
Other family types (reference = Two biological or adoptive parents)		1.32 (1.15–1.51)***	1.33 (1.16–1.53)***
Family wealth medium-high (reference = low)		0.84 (0.76–0.93)**	0.85 (0.77–0.94)***
Perceived family support		0.87 (0.84–0.91)***	0.87 (0.83–0.92)***
Perceived peer support		0.97 (0.93–1.02)	0.97 (0.93–1.02)
Perceived teacher support		0.85 (0.78–0.92)***	0.85 (0.78–0.92)**
Perceived classmate support		0.94 (0.86–1.02)	0.94 (0.85–1.03)
REGIONAL LEVEL (*N* = 21)			
GDP per capita			0.95 (0.93–0.98)***
Gini			1.25 (1.06–1.47)**
RANDOM EFFECT			
Variance components	0.26 (0.51)	0.22 (0.47)	0.08 (0.26)
	$\chi^2_{(20)} = 239.87^{***}$	$\chi^2_{(20)} = 185.54^{***}$	$\chi^2_{(18)} = 66.40^{***}$

$^{***}p < 0.001$; $^{**}p < 0.01$; # The number of regional levels totals 21 because the Trentino data comprised two different geographic areas (i.e., Bolzano and Trento).

Such motivations are known to be positively associated with problem gambling in adolescents and young adults (e.g., Canale et al., 2015b; Lambe et al., 2015). Adolescents, like adults, may engage in potential risky behaviors (e.g., gambling and alcohol consumption) as a means to cope with feelings of deprivation and social disadvantage.

According to the conceptual framework of harmful gambling (Abbott et al., 2013), contextual macro-level factors such as gambling opportunities and macroeconomic indicators can help in explaining the potential effect of income inequality on ARPG. As gambling venues (in Australia, New Zealand and the United Kingdom) tend to be in areas of social deprivation (Wohl and Davis, 2017), being exposed to such a range of gambling opportunities may also foster pro-gambling attitudes (e.g., social approval and condoning of gambling), which in turn, could increase gambling involvement among adolescents. Additionally, income inequality may also be associated with lower government spending on public health services, thereby affecting the extent of exposure adolescents may have had to health promotion campaigns for reducing problem gambling.

Second, individuals who live in a region in which the GDP per capita is higher, have lower odds of being ARPGs. This finding supports neo-material theory (Lynch et al., 2000) in which higher availability of resources is associated with better health outcomes. It is possible to argue that wealthy regions have enough resources for health service provisions and benefits, such as expenditure on public health, which was been found to be associated with lower levels of probable gambling problems in representative samples of students living in nine European countries (Molinaro et al., 2014). Beyond income and wealth, differences in prevalence rates among regions may also be partially explained by large societal events, like natural disasters. In a study of risk related to natural disasters, increased risk-taking behavior was observed among disaster survivors (Norris et al., 2002; Vlahov et al., 2004) and perceived threat-to-life increases risk taking (Ben-Zur and Zeidner, 2009).

Third, the present study reported different results regarding the differential and unique impact of support sources on ARPG, that is, which source is more able to reduce the odds for adolescent to be at-risk and problematic gamblers. Consistent with results from previous studies (Hardoon et al., 2004; Räsänen et al., 2016; Canale et al., 2017), results from the main effects models indicated that adolescent students who perceived more support from parents and teachers reported less involvement in ARPG. It possible that positive relationships with parents and non-family adult mentors (e.g., teachers) foster feelings of safety in out-of-home settings among adolescents, and perceive the wider adult community as being supportive (e.g., Brooks et al., 2012), which in turn appears to have important preventive functions in inhibiting harmful forms of gambling. Additionally, results did not demonstrate that social support from peers and classmates accounted for ARPG. There are several observations that can be made regarding the absence of this effect. First, the study of the importance of social support sources indicated that friends and parents were perceived as equally supportive by 9- to 15-year-olds, but for those aged 16 to 18 years, the support of friends exceeded the support of parents (e.g., Bokhorst et al., 2010). Thus, it could be that the protective effect of peer support on gambling becomes more salient in older age adolescents. Consequently, future studies should include students from other school grades. Another explanation may be related to the fact that social motives (e.g., gambling to increase social affiliation) do not generally predict problem gambling in adolescents and young people (Stewart and Zack, 2008; Dechant and Ellery, 2011; Lambe et al., 2015).

Finally, contrary to what was hypothesized, no differences were found in perceived social support accounting for the association between income inequality and ARPG. According to the findings, the detrimental impact of regional inequality on adolescent gambling was the same for adolescents perceiving different levels of social support. However, other characteristics of the social environment (not considered in the current study) might amplify the impact of income inequality, such as the relevant dimensions of economic, social, and cultural capital that have been found to explain social inequality in adolescent health (e.g., food intake; De Clercq et al., 2016). The present study only considered social relationships that involved the adolescents' immediate social environment (i.e., the "microsystem" of family members, peer groups, classmates, and teachers) but social relationships outside this microsystem across neighborhoods, racial groups, and societies (more related to status competition) might moderate the

association between income inequality and gambling (Putnam, 2000). For these reasons, future research is needed in order to explore other unconsidered factors related to income inequalities.

The present study is not without its limitations. First, the study utilized self-report data leading to well-known biases (such as memory recall biases and social desirability biases, etc.). Thus, the study depended upon adolescents' reports of and involvement in gambling and relationships (e.g., family wealth, social support). It would have been helpful to corroborate such self-reports with other informants such as parents or teachers. Second, the HBSC-Italy survey did not collect additional information on gambling behavior (e.g., gambling expenditure), nor was there any information about the types of gambling engaged in. Because previous studies have found that deprived areas present more gambling opportunities (e.g., in the form of gaming machines; Livingstone, 2001), future research should aim to explore the association between gambling frequency and income inequality. Third, a significant limitation of the present study was the cross-sectional design. Consequently, it cannot assume causality or rule out reverse causality. In fact, it is also possible that ARPG could lead to lower regional wealth or higher income inequality. For instance, the 2017 report of the Institute of Political, Economic and Social Studies (EURISPES, 2017) reported that gambling disorder represents the fourth leading cause of poverty in Italy. Examining these relationships longitudinally would provide a better understanding relating to the causal role of income inequality in the development of gambling problems among adolescents. Another limitation deriving from the cross-sectional nature of the data concerned the potential cumulative effect of inequality over time (e.g., McDonough et al., 2010). Future studies should focus on analyzing the differential effect that a different exposure to inequalities over time can have on adolescent gambling. Fourth, in accordance with the HBSC protocol, the participants were only 15-year-old students. Future studies should therefore investigate the association between income inequality and adolescent gambling severity with students from other school grades. Finally, the results of the present study cannot be generalized to 15-year-old students in other parts of the world where the socio-political structures may be very different.

Despite these limitations, to the best of the authors' knowledge, the present study is the first to investigate the effects of income inequality on ARPG in a large sample representative of the Italian high school population. In particular, the findings give support to the idea that adolescents who live in more unequal (and poor) regions show higher gambling-related harms. For this reason, policy actions are needed to redistribute wealth and create more egalitarian societies for reducing adolescent ARPG. Consequently, policy actions that concern limiting gambling need to support raising taxes on gambling, especially in a low gambling tax country like Italy. For example, Italy imposed tax rates on machines outside casinos up to four times lower than those imposed by Austria and Denmark (up to 13% in Italy compared to an average 55% in Denmark, and up to 50% in Austria [i.e., taxation of gambling services as a percentage of net revenue] (Sfetcu, 2016). Other policy recommendations to policymakers concerning adolescent problem gambling could include: (i) providing regions with more funding for implementing prevention programs at school level; (ii) limiting access to gambling opportunities (e.g., by imposing stricter penalties for gambling operators who allow minors to gamble illegally), and (iii) increasing public awareness (e.g., educating parents, teachers, and school administrators) that adolescents are not immune to gambling-related harms. In addition to redistributive fiscal policies aimed at promoting income equality at the regional level, our findings underline the need to implement prevention programs starting from more unequal regions, where prevention efforts are most needed. Educational interventions should also teach adolescents to recognize the attitudes and behaviors that discriminate, and reach out to adolescents in unequal areas for pro-responsible gambling policy. With regard to social support, the present study suggests that prevention efforts may benefit from being particularly mindful of those adolescents who lack social support from parents and teachers. Adolescents who perceived themselves as receiving less parental supervision are more likely to be at-risk and problem gamblers or frequent gamblers (e.g., Hardoon et al., 2004; Canale et al., 2016b). Thus, prevention programs could focus on teaching parents to develop trusting (and non-intrusive) parent–child relationships that foster honest self-disclosure. In conclusion, according to the adolescent risk behavior model incorporating youth gambling risk factors (Dickson et al., 2002 a model adapted from Jessor, 1998), the present study provides an example of how possible risk and protective factors operate in and across a number of domains (e.g., social environment and perceived environment). In conclusion, the present study for the first time (to our knowledge) was able to show that income inequality may have a contextual influence on ARPG. As this is the first demonstration of this association, substantial replication is required.

AUTHOR CONTRIBUTIONS

NC designed the data collection instruments, conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted. AV carried out the initial analyses, designed the data collection instruments, and coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted. ML conceptualized and designed the study, designed the data collection instruments, reviewed and revised the manuscript, and approved the final manuscript as submitted. MG reviewed and revised various stages of the manuscript, and approved the final manuscript as submitted. AB designed the data collection instruments, and coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted. GL designed the data collection instruments, and coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted. PL designed the data

collection instruments, and coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted. LS reviewed and revised the manuscript, and approved the final manuscript as submitted. MS reviewed and revised the manuscript, and approved the final manuscript as submitted. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Problem Gambling among Adolescent Girls in Croatia—The Role of Different Psychosocial Predictors

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Although, compared to boys, adolescent girls gamble less often and less problematically, prevalence studies still show significant numbers of at risk/problem gamblers among girls. However, girl gambling has been on the sidelines of adolescent gambling research. The available studies usually focus only on a narrow set of correlates often ignoring that adolescent gambling is a complex phenomenon determined by various factors. Also, they often measure gambling related consequences with instruments that are not specifically developed for use on adolescents. In order to contribute to a better understanding of adolescent gambling this study focuses on problem gambling among girls. We consider different social, cognitive, motivational and behavioral factors as predictors of girl problem gambling. A total of 1,372 high-school girls from 7 Croatian cities participated in the study. They provided data on their gambling activities, peer gambling, cognitive distortions related to gambling, motivation for gambling, and levels of general risky behavior. As the only instrument developed specifically for use on adolescents, the Canadian Adolescent Gambling Inventory was used to examine adverse gambling consequences. Results show 7.4% of girls can be considered regular gamblers, and out of those who gambled at least once in their lifetime ($n = 862$), 11.2% already experience mild adverse consequences because of their gambling (at risk gamblers), with 3.2% experiencing serious consequences (problem gamblers). In general, girls seem to prefer lotto and scratch cards, but sports betting seems to be the preferred game of choice among regular girl gamblers. A hierarchical regression model confirmed the importance of much the same factors identified as risky for the development of problem gambling among adolescent boys—cognitive distortions, motives to earn money, to be better at gambling and to relax, the experiences of winning large and the drive to continue gambling, together with social factors such as having friends who also gamble, being involved in other risky and delinquent behavior and higher gambling frequency. Results call into question the importance of the motive to feel better for adolescent girls problem gambling. We discuss implications of our findings for both universal and indicated youth gambling prevention programs.

Keywords: adolescent gambling, problem gambling, adolescent girls, risky behavior, gender specific risk factors

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INTRODUCTION

Studies of adolescent gambling behavior consistently show that girls are less involved in gambling than boys (Dowling et al., 2017). Also, there are less problem gamblers among girls than boys, with an estimated ratio between 1:3 and 1:5 (Jacobs, 2004). However, in spite lower prevalence rates there are several reasons why investigating gambling participation and adverse consequences in girls is important. Prevalence of both problem (1–8%) and risky gambling (1–12%) among adolescent girls is still significant (Hardoon et al., 2004; Ellenbogen et al., 2007; Donati et al., 2013; Kristiansen and Jensen, 2014). Also, girls seem to develop gambling problems more rapidly than boys, and manifest a wide array of other mental health issues in comorbidity with their gambling (Chalmers and Willoughby, 2006; Ellenbogen et al., 2007; Desai and Potenza, 2008; Jackson et al., 2008). Longitudinal data suggests that girls displaying problem gambling behavior during their adolescence remain problem gamblers in adulthood (Winters et al., 2002). Studies investigating adult gambling show consistent gender differences in gambling preferences and some gender specific pathological gambling predictors (Hing et al., 2016), leaving one to question whether these are just mirrored from female specific factors which arise in adolescence. In addition, the literature on adolescent gambling is dominated by boys, and often assumes that what is true for boy gamblers is also true for girl gamblers. At the same time, most determinants that predict adolescent problem gambling might be reliable only for boys and not girls. In line with this, several studies have questioned the utility of the same set of risk factors as predictors of girl gambling (Chalmers and Willoughby, 2006; Ellenbogen et al., 2007; Donati et al., 2013).

In order to advance the existent literature, in this study we focus exclusively on girls and examine their gambling preferences, and predictors of their problem gambling. Since problem gambling is a complex phenomenon, we consider a wide array of social, cognitive, motivational and behavioral factors, and employ a diagnostic instrument developed specifically for use on adolescents.

Girls usually start gambling in their early to middle teens, which is the same as boys (Gupta and Derevensky, 1998; Kristiansen and Jensen, 2014). Also, there seems to be no difference in overall life-time prevalence of gambling, with the majority of both girls and boys gambling at least once in their lifetime (Olason et al., 2006). Between 3 and 10% of girls seem to be regular gamblers, involving themselves in different gambling activities once a week or more often (Shapira et al., 2002; Johansson and Götestam, 2003; Skokauskas and Satkeviciute, 2007). One study even found similar numbers of adolescent boys and girls that gamble regularly (Ellenbogen et al., 2007).

Adolescent girls seem to like lotto and scratch cards as their preferred games of choice (Gupta and Derevensky, 1998; Felsher et al., 2004; Ellenbogen et al., 2007; Kristiansen and Jensen, 2014; Elton-Marshall et al., 2016). However, given the low addictive potential of lotto and scratch cards, it is possible that once they become problem gamblers girls no longer choose these games, but other more addictive gambling activities like sports betting and gaming machines. For example, studies on adults show women pathological gamblers prefer bingo and slot machines over other gambling activities (Holdsworth et al., 2012). We found only one study that examined the preferred games of choice among girl problem gamblers, which showed female problem gamblers prefer to play cards and bet on sports, together with lottery games (Ellenbogen et al., 2007). More research is needed in different geographic regions, different gambling markets and with different gambling activities before firm conclusions can be drawn.

A recent research review estimates adolescent problem gambling rates to be between 0.2 and 12.3% worldwide (Calado et al., 2016). Rates of adolescent girls' problem gambling are smaller, and differ based on the instrument used to estimate problem gambling, as well as geographic region. American and Canadian data indicates that between 1 and 3.6% satisfies the criteria for problem gambling (Derevensky and Gupta, 2000; Shapira et al., 2002; Hardoon et al., 2004; Ellenbogen et al., 2007). European data is very heterogenous, with the lowest rates of problem gambling observed among girls in Northern Europe—0.1–5.3% (Iceland—Olason et al., 2006, 2011; Denmark—Kristiansen and Jensen, 2014; Norway—Johansson and Götestam, 2003; Hanss et al., 2015; Finland—Castrén et al., 2015; Lithuania—Skokauskas and Satkeviciute, 2007). A Romanian study found much higher rates–8.3% of girls to be problem gamblers, and an additional 17.7% to be at-risk gamblers (Lupu and Todirita, 2013). In Italy, Bastiani et al. (2013) found 13.6% of girls to be moderate risk and problem gamblers. However, these prevalence rates might be misleading because they are based on a limited set of studies. Researchers interested in adolescent gambling prevalence should routinely report prevalence rates separately for boys and girls to overcome this issue.

Although these prevalence rates are smaller than rates for boys (see Calado et al., 2016) they are still relatively high, given that gambling is illegal for minors in most countries. Countries differ with regard to both accessibility and availability of gambling venues, which is one of the reasons why prevalence rates of adolescent gambling are so diverse. Given the scarcity of data on adolescent girls, further research is needed in different contexts in order to paint a full picture of girl gambling. Croatia, with its liberal gambling market, and high accessibility and availability of gambling venues, provides such a context.

Data on prevalence of gambling participation and problem gambling among adolescent girls undoubtedly indicate that girls do gamble and do so problematically and hence need both prevention and treatment interventions just as much as boys. However, studies focusing on correlates of girl problem gambling, which could inform said efforts, are very scarce and seem to be rather inconsistent. Furthermore, it is still unclear which risk factors of adolescent problem gambling are shared between boys and girls, and which, if any, are girl specific.

Most of the studies interested in gender differences examine the comorbidity of gambling and other mental health issues, although with inconsistent results. Studies focusing on gambling involvement showed that girls with more depression symptoms gamble more frequently (Gupta and Derevensky, 1998; Martins

et al., 2007). However, a longitudinal study did not find depression as a significant predictor of higher gambling involvement, neither among girls, nor among boys (Yücel et al., 2015). Substance use (tobacco, alcohol, drugs) was identified as a risk factor for girls in some studies (Gupta and Derevensky, 1998; Martins et al., 2007), but not in others (Casey et al., 2011). Moreover, in a longitudinal study, only alcohol use (but not drug use) in early adolescence predicted risky gambling behavior in late adolescence, and this was true for both girls and boys (Yücel et al., 2015).

Studies that focus on problem gambling symptoms, and not just gambling frequency, also seem to be inconsistent. Desai et al. (2005) found no gender differences in alcohol and substance use, but did find higher depression rates among girl problem gamblers. In contrast, Ellenbogen et al. (2007) found no gender differences in rates of depression and alcohol use, but did find higher rates of drug use among girl problem gamblers.

According to some authors, gambling can be considered as part of the general problem behavior framework (Dickson et al., 2002; Barnes et al., 2011) and numerous studies confirm that gambling behavior occurs in comorbidity not just with substance use, but with general risky and anti-social behavior as well (Wanner et al., 2009; Dowling et al., 2017; Mishra et al., 2017). However, studies comparing boys and girls on this issue are very scarce, and include only measures of gambling frequency and not problem gambling. For example, Jackson et al. (2008) found anti-social behavior to be a risk factor for higher gambling involvement among boys, but not girls. On the other hand, in a longitudinal study, peer delinquency predicted gambling participation only among girls, and not boys (Barnes et al., 2005). Another longitudinal study, although focused only on adolescent boys, also showed that levels of aggressive and disruptive behavior in childhood and early adolescence predicted at risk/problem gambling in later adolescence (Martins et al., 2013). However, further research that focuses on problem gambling and not just gambling frequency is needed before any conclusions on the role of risky and delinquent behavior for girl gambling/problem gambling can be drawn.

Desai et al. (2005) speculate that girl gambling reflects a particularly deviant path characterized by a complicated clinical picture involving disrupted mental health, especially mood disorders and substance abuse. Going into adulthood, gambling in order to overcome mental health problems might be the primary reason for women gambling (Thomas and Moore, 2001). Several studies show that women are more likely to use gambling as an escape from worry and other life problems, while men seem to gamble in order to win money and because they believe that they can influence the outcome (Wenzel and Dahl, 2009; Balodis et al., 2014). In contrast to gender differences in adult gambling motivation, studies on adolescents seem to show different patterns. Boys endorse most of the reasons for gambling (to make money, escape problems, to feel better, to be entertained) more than girls (Jackson et al., 2008; Dodig, 2013; Kristiansen and Jensen, 2014).

However, if research wants to inform future prevention and treatment efforts, an important question is whether different motives predict problematic gambling in different ways for boys and girls. With this regard studies on adult gamblers show much less gender differences. Several studies found that expectations to win money and to have a good time predicted gambling problems for both women and men (Spurrier and Blaszczynski, 2014; Hing et al., 2016). Gambling to escape problems seems to be the only consistent motive that predicts women's but not men's gambling problems (Walker et al., 2005). However, we were not able to find studies that investigate gender differences regarding the contribution of motivation for problem gambling in adolescence, so future research is needed on this point.

It is clear from this short review of available research on gender differences in adolescent gambling, that our knowledge of female gambling, especially female problem gambling is very limited. In addition, current findings seem to be rather inconsistent, and further research is needed before any of the factors associated with adolescent problem gambling can be branded as girl specific.

In this study we try to extend the available literature by focusing solely on girls. We had two main goals—to examine gambling participation and preferences among Croatian adolescent girls and girl problem gamblers, and to investigate whether risk factors commonly associated with adolescent problem gambling predict girl problem gambling as well. In order to do so, we employed a comprehensive model of cognitive, motivational, social and behavioral factors which we based on previous research showing the most common predictors of adolescent problem gambling (Derevensky and Gilbeau, 2015), and other Croatian studies investigating adolescent problem gambling (Dodig, 2013; Ricijas et al., 2016a).

We included different types of cognitive distortions as *cognitive factors* in our model. Previous studies on adolescents show that distortions such as poor understanding of odds and probabilities, superstitious thinking and illusions of control predict more adverse gambling consequences and problems (Goodie and Fortune, 2013), and this was found for both boys and girls (Donati et al., 2013). In line with these studies, we expected different types of cognitive distortions to significantly predict girl problem gambling.

As *motivational factors*, we were interested in motives to win money, to be better at gambling, to feel better and to relax. These motives have been linked to more adverse gambling consequences and problems in previous research (Derevensky and Gilbeau, 2015). Even though research on adults shows women primarly gamble to feel better, and not to earn money, based on the available studies with adolescents where much less gender differences were observed, we expected that all four motives will predict more severe gambling problems in girls. Furthermore, previous studies showed that experiencing large wins leads to a specific motivation or drive to continue gambling after winning and that this specific motivation is one of the strongest single predictors of gambling problems (Turner et al., 2006; Ricijas et al., 2016a). In line with this, we expected that both previous large wins experience and the drive to continue

gambling after winning to be potent predictors of girl problem gambling.

We also included *social factors*, namely peer gambling involvement, in our study. Although peer gambling has been associated with adolescent problem gambling in previous research (Delfabbro and Thrupp, 2003; Hardoon et al., 2004; Langhinrichsen-Rohling et al., 2004; Dickson et al., 2008), studies investigating girl specific problem gambling predictors generally overlook these factors. One study (Donati et al., 2013) found peer gambling to predict problem gambling only among boys, but not girls. On the other hand, some authors argue that peer related factors might be more important for girls than for boys (Chalmers and Willoughby, 2006). However, peer influence is a strong factor that shapes adolescent behavior (Ryan, 2001), especially risky behavior and risky decision making (Chassin et al., 2004; Gardner and Steinberg, 2005; Simons-Morton et al., 2005). Since gambling is often considered part of the general problem-behavior framework (Dickson et al., 2002; Barnes et al., 2011), we expected that having friends that gamble will be tied to more problematic girl gambling.

We examined gambling frequency and other risky behaviors, as *behavioral factors*. In general, strong links exist between levels of risky and delinquent behavior and adolescent problem gambling (Wanner et al., 2009; Welte et al., 2009), although we were not able to find studies examining gender differences in this link. Studies on delinquent girls who are involved in risky behavior during their adolescence show high comorbidity between a wide array of different risky and antisocial behaviors (Zahn et al., 2010). Based on this, we expected that levels of general risky and delinquent behaviors will be associated with more problematic gambling among adolescent girls.

Gambling frequency is one of the strongest predictors of problem gambling (Boldero et al., 2010; Raisamo et al., 2013). Although frequency alone is not enough to diagnose problematic gambling, adolescents who gamble more frequently routinely show more adverse gambling consequences and problems, so we expected the same will be true for adolescent girls. Similarly, those who exhibit more gambling problems also seem to be involved in a wider array of gambling activities (Kristiansen and Jensen, 2014), something we also expected to find on girls.

All the available studies examine girl gambling or gender differences in gambling by relying on commonly used screening instruments like DSM-IV-MR-J (Fisher, 2000) or SOGS-RA (Winters et al., 1993). Since these have been adapted from conceptualizations of adult gambling, they have been criticized for not adequately capturing adolescent problem gambling (Stinchfield, 2010; Dodig, 2013). In order to investigate different kinds of gambling related consequences and harms, typically reported by adolescents, in this study we use the only existing screening instrument developed for use especially on adolescents. The Canadian Adolescent Gambling Inventory (CAGI; Tremblay et al., 2010) recognizes that adolescents can have different psychological, social, behavioral and financial costs because of their gambling, and takes all of these into account when categorizing no-risk, at-risk and problem gamblers. Using this instrument to investigate girl problem gambling enables us to further extend the available literature.

METHOD

Participants

A total of $N = 1{,}372$ high-school girls from 7 Croatian cities participated in the study. Both major Croatian regional centers, as well as smaller Croatian towns were included. In regional centers (Zagreb, Rijeka, Osijek, Split), high-schools were randomly selected from the list of available schools in the city. In smaller towns, a convenient sample of schools was used. Age ranged from 14 to 20 years ($M = 16.45$, $SD = 1.154$). All three Croatian high-school programs (general education, 3-year and 4-year vocational schools), and all levels of high-school grades are represented in the sample. In terms of high school programs, each category closely represents the national distribution of the number of students enrolled in these programs. Also, there is an approximately equal number of first, second and third grade students while, due to the absence of the fourth grade in 3-year high-school programs, the proportion of students who attend the fourth grade is slightly lower. The basic socio-demographic characteristics of the sample are presented in **Table 1**.

Measures

General socio-demographic information such as age, grade and gender were collected.

We used the revised version of **Gambling Activities Scale** (Ricijas et al., 2011) to assess gambling frequency. We focused on six games: (1) sports betting, (2) lotto, (3) scratch cards, (4) slot machines, (5) electronic roulette, and (6) betting on virtual races. The respondents were asked to evaluate the frequency of their gambling (on a 5 point scale, from *0 = never* to *5 = every day or almost every day*). In order to assess the overall frequency of their gambling, we averaged the result for all games of chance. Higher results indicate more frequent gambling with the reliability of this index being satisfactory ($\alpha = 0.62$).

The severity of gambling related consequences was measured by the **Canadian Adolescent Gambling Inventory (CAGI)** (Tremblay et al., 2010). It is the first instrument designed specifically for the assessment of adolescent problem gambling. Therefore, its items are in line with the developmental age of the

TABLE 1 | Sample description ($n = 1{,}372$ high-school girls).

City/ Town	Zagreb	Split	Rijeka	Osijek	Koprivnica	Slavonski brod	Vinkovci
N	282	321	210	220	109	117	113
%	20.6	23.4	15.3	16.0	7.9	8.5	8.2

Type of school	3-year vocational school	4-year vocational school	General education
N	247	452	673
%	18.0	32.9	49.1

Grade	1st	2nd	3rd	4th
N	411	353	335	268
%	30.1	25.8	24.5	19.6

respondents (item example: "How often have you taken money that you were supposed to spend on lunch, clothing, movies, etc. and used it to gamble/bet or to pay off your gambling/betting debts?"), who report how often they felt or behaved in a certain way on a 4 point scale (*0 = never* to *3 = almost always or 7 and more times*). In this study we used only the nine items which provide a composite measure, a General Problem Severity Subscale (GPSS) ($\alpha = 0.79$). Depending on the total result of this measure, participants are classified into 3 categories: (1) no problem ("green light"), (2) low to moderate severity ("yellow light"), and (3) high severity ("red light"). Several studies confirm good classification accuracy of the GPSS measure–Se = 0.97 and Sp = 0.93 (Tremblay et al., 2010); Se = 0.93, Sp = 0.99 and hit rate = 0.98 (Jiménez-Murcia et al., 2017).

The **Gambling Beliefs Scale** (Ricijas et al., 2011) is a 14-item scale which measures gambling related cognitive distortions. There are two subscales: (1) Superstition and incorrect understanding of chances and probability (9 items, $\alpha = 0.81$ item example: *"Some activities (rituals etc.) increase the probability of winning at gambling."*) and (2) Illusion of control (5 items, $\alpha = 0.74$, item example: *"Gambling outcomes can be predicted."*). The respondents report on their level of agreement with each of the items on a four-point scale ranging from *1 (strongly disagree)* to *5 (strongly agree)*. The scale provides two separate results, one for each factor with higher results indicating more cognitive distortions associated with gambling.

Risk and delinquent behavior was measured with a self-report scale by Atlanta et al. (2005). In this 25-item scale, various types of risk and delinquent behavior are listed (for example stealing, vandalism, aggressive behavior etc.) and the respondents indicate how many times in their life have they done something or behaved in a certain way (*0 = never, 1 = one to two times, 2 = three to four times, 3 = five or more times*). The item scores are averaged to form a total score. Again, a higher result indicates more involvement in such behavior. Cronbach alpha was $\alpha = 0.87$.

Motives for Gambling Check-List (Ricijas et al., 2011) was created to assess motivation for gambling. In this study, the participants were asked "Why do you gamble/bet?," and then offered four potential motives (to relax, to feel better, to earn money, to become better in gambling). For each of them, participants indicated how often they gamble because of that specific motive *(0 = never because of that; 4 = always because of that)*. The emphasis is on these 4 motives only since previous studies have shown them to be especially significant when it comes to explaining gambling related problems (Gupta and Derevensky, 1998; Moore and Ohtsuka, 1999; Delfabbro and Thrupp, 2003; Wood and Griffiths, 2007; Yip et al., 2011; Derevensky and Gilbeau, 2015).

Furthermore, respondents were asked about their **peers' gambling** habits. Specifically, they were asked to remember a few of their closest friends and indicate how often (*0 = never to 5 = every day)* they think their friends are involved in (a) sports betting, (b) slot machines, and (c) electronic roulette. A total score was formed by summing responses on all three items creating a peer gambling index. Higher results indicate higher instances of peer gambling. The reliability of such an index was satisfactory $\alpha = 0.76$.

Since **experiences while gambling** are particularly relevant for the development and maintenance of problem gambling, we wanted to gain insight into participants' feelings of experiencing reinforcement while gambling. Therefore, we asked them: (1) "How often have you had an experience of winning a large sum of money while gambling?" *(1 = never; 4 = many times)* and (2) "When winning a large sum of money by gambling it encourages me to continue gambling." *(1 = not at all; 5 = completely true for me)*.

Procedure

The data was collected in school classrooms, during regularly scheduled classes. Consent to participate was considered implicit by the return of the questionnaire, after the participants were fully informed about the study. Students could decline participation at any point during instrument administration. The researcher distributed the paper-pencil surveys and students completed them independently and anonymously. The full survey took ∼45 min to complete. During all of the procedures, the principles of the Code of Ethics for Research with Children (Ajdukovic and Kolesaric, 2003) were respected. The ethics committee of the Faculty of Education and Rehabilitation Sciences, University of Zagreb approved the research. Furthermore, the study had written support from Croatian Ministry of Education, Science and Sport and Croatian Teacher Training Agency. Afterwards, all participating schools received a descriptive summary report of results on a group level.

Statistical Analyses

Data was analyzed using the statistical package SPSS version 20.0 (SPSS Inc., Chicago, IL). We calculated descriptive statistical parameters in order to analyze frequency of gambling and problem gambling. One-way ANOVA was used to examine differences in gambling frequency among different categories of gamblers. We examined associations between study variables with Pearson's correlation coefficients. We employed hierarchical regression analyses in order to test which correlates significantly predicted problem gambling among Croatian adolescent girls.

RESULTS

Descriptives

First, we examined the frequency of engaging in the six gambling activities (sports betting, lotto, scratch cards, slot machines, electronic roulette, and virtual betting). Based on criteria proposed by Felsher et al. (2004) we categorized girls gambling activities in three categories—never played; played occasionally (combining answers "once a year or less" and "once a month"); and played regularly (once a week or more often). A total of 7.4% can be considered regular gamblers, playing at least one of the six examined activities once a week or more often. Data on specific activities, and preferred games of choice for Croatian high-school girls can be seen in **Table 2**.

Scratch cards and lotto are the most common games played by girls, with significant numbers of girls betting on sports and

TABLE 2 | Frequency of Gambling (*N* = 1,372).

	Never		Occasionally		Regularly	
	f	%	*f*	%	*f*	%
Sports Betting	1,145	83.5	189	13.8	38	2.8
Lotto	886	64.6	457	33.3	29	2.1
Scratch Cards	701	51.1	638	46.5	33	2.4
Slot machines	1,199	87.4	152	11.1	21	1.5
Electronic roulette	1,344	98	23	1.7	5	0.4
Betting on virtual races	1,296	94.5	62	4.5	14	1.0

TABLE 3 | Frequency of regular gambling according to CAGI categories (*N* = 862).

	CAGI green light		CAGI yellow light		CAGI red light	
	f	%	*f*	%	*f*	%
Sports Betting	15	2.1	16	16.8	7	25.9
Lotto	15	2.1	11	11.6	3	11.1
Scratch Cards	20	2.8	12	12.6	1	3.7
Slot machines	11	1.5	2	2.1	8	29.6
Electronic roulette	1	0.1	2	2.1	2	7.4
Betting on virtual races	7	1.0	4	4.2	3	11.1

playing slot machines. A third of girls occasionally play lotto, and about half of them occasionally play scratch cards. An additional 2% of girls play these two games regularly. Over 10% of girls bet on sports occasionally, with almost 3% betting on sports regularly. It is interesting that amongst the games that are played regularly, sports betting is at the top of the hierarchy, together with lotto and scratch cards. Slot machines are also fairly common, with 11% of girls playing this game occasionally and an additional 1.5% regularly. Betting on virtual races and electronic roulette seem not to be preferred by girls.

According to the CAGI general problem gambling severity index (GPSS), the majority of girls are not experiencing any adverse gambling related consequences (91.6%). However, 1.7% of girls are already experiencing serious consequences because of their gambling ("red light"), and 6.7% are experiencing low to moderate consequences ("yellow light"). This means almost 10% of high-school girls are at risk to develop or have already developed gambling problems (see more on boy and girl gambling prevalence in Ricijas et al., 2016b).

However, when we look only at those girls who have gambled at least once in their lifetime ($N = 862$) the numbers are more alarming—11.2% are experiencing low to moderate consequences and 3.2% are already experiencing severe consequences because of their gambling. In **Table 3** we present information on preferred games of choice based on different CAGI categories. Only games played regularly (once a week or more often) are included. Results show that amongst girls with severe gambling related consequences slot machines and sports betting seem to be the preferred games of choice, with a third of girls being involved in these activities. Scratch cards, being one of the most frequently played game overall (see **Table 2**), is hardly represented among those girls who already have severe gambling related consequences, with only one seventh of at risk gamblers (yellow light) regularly playing this game.

We also examined differences between CAGI categories in the number of different games girls play regularly. Results show that social gamblers (green light) have one preferred game of choice, with only 1.5% choosing to play two or three games regularly. Among at-risk gamblers (yellow light) there is 12.7% who play between two and four different games regularly. And among problematic gamblers (red light) 18.5% play between two and four different games regularly. In this sample none of the girls play more than four of the examined games regularly. We calculated a one-way ANOVA using the number of games they play regularly. The analysis showed a significant difference between CAGI categories ($F = 60.886$, $p < 0.0001$). *Post-hoc* testing showed problematic gamblers playing the most games regularly, followed by at-risk gamblers and then non-risk gamblers (*p's* between all groups < 0.001).

Predictors of Adverse Gambling Consequences among Girls

Our second goal was to examine different cognitive, motivational, social, and behavioral predictors of problem gambling among adolescent girls. Descriptives and correlations between all predictors and problem gambling are presented in **Table 4**. We did this, and all subsequent analyses, only on the subsample of girls who gambled at least once in their lifetime, since one needs to be gambling in order to experience any adverse gambling related consequences.

Bivariate correlations between predictors and gambling related consequences are all significant and in expected directions. Those with more cognitive distortions, higher motivation and drive for gambling, who gamble more and have friends who gamble more, and those with higher levels of risk and delinquent behavior have more adverse consequences because of their gambling. The predictors themselves are also intercorrelated, so further analysis is warranted in order to control for this shared variability.

We grouped our predictors based on the content of what they are measuring—cognitive, motivational, social, and behavioral factors. Then we decided to enter them into a six-step hierarchical regression analysis, entering variables most distant from gambling first (risk and delinquent behavior in step 1; peer gambling in step 2), moving to the factors more proximal to gambling (cognitive distortions related to gambling in step 3; motives for gambling in step 4; experiences while gambling in step 5, and gambling frequency in step 6). This strategy takes into account the complexity of problem gambling, and allows us to examine the different predictive value of specific problem gambling determinants.

Results are presented in **Table 5**. The entire model explains 41.5% of adverse gambling consequences among adolescent girls. All VIFs ranged from 1.079 to 1.661 showing no multi-collinearity problems in the analysis. Every step significantly improved prediction when entered into the analysis. Also, all

TABLE 4 | Descriptives and correlations between study variables (*N* = 862; high-school girls who gambled at least once in their life-time).

	CAGI	RISK	PG	COGDIS1	COGDIS2	M1	M2	M3	M4	Experience 1	Experience 2	FG
CAGI	–	0.336**	0.249**	0.202**	0.185**	0.413**	0.379**	0.361**	0.464**	0.470**	0.401**	0.418**
Risk and delinquent behavior (Risk)		–	0.255**	0.165**	0.149**	0.226**	0.255**	0.313**	0.357**	0.225**	0.229**	0.287**
Peer gambling (PG)			–	0.084*	0.039	0.130**	0.142**	0.139**	0.171*	0.218**	0.183**	0.248**
Superstition and incorrect understanding of chances and probability (COGDIS1)				–	0.567**	0.277**	0.288**	0.149**	0.314**	0.203**	0.186**	0.140**
Illusion of control (COGDIS2)					–	0.194**	0.178**	0.152**	0.261**	0.159**	0.174**	0.119**
Motive to relax (M1)						–	0.530**	0.204**	0.464**	0.319**	0.294**	0.298**
Motive to feel better (M2)							–	0.332**	0.514**	0.315**	0.320**	0.268**
Motive to earn money (M3)								–	0.269**	0.349**	0.434**	0.359**
Motive to be better in gambling (M4)									–	0.319**	0.345**	0.336**
Experience of winning a large sum of money (Experience 1)										–	0.282**	0.500**
Drive to continue with gambling after winning a large sum of money (Experience 2)											–	0.277**
Mean frequency of gambling (FG)												–
Mean	0.75	1.69	4.65	1.86	2.60	2.21	1.18	2.04	1.19	1.38	1.91	2.69
SD	1.972	0.398	4.070	0.639	0.784	0.570	0.504	1.120	0.596	0.728	1.183	2.289
Minimum	0	1	0	0	1	1	1	1	1	1	1	1
Maximum	17	3.75	15	4.6	5	4	4	4	4	4	5	19
Theor. range	0–27	1–4	0–15	1–5	1–5	1–4	1–4	1–4	1–4	1–4	1–5	0-30

*$p < 0.050$; **$p < 0.010$.

TABLE 5 | Results of hierarchical regression analysis.

		Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
		β	β	β	β	β	β
1	Risk and delinquent behavior	0.340***	0.291***	0.263***	0.111***	0.093**	0.078*
2	Peer gambling		0.181**	0.179**	0.130**	0.088**	0.075*
3	Superstition and incorrect understanding of probability and chance			0.091*	−0.022	−0.031	−0.027
	Illusion of control			0.101*	0.056	0.041	0.041
4	Motive to earn money				0.183***	0.086**	0.065*
	Motive to relax				0.204***	0.155***	0.141***
	Motive to be better in gambling				0.233***	0.190***	0.176***
	Motive to feel better				0.049	0.025	0.029
5	Experience of winning a large sum of money					0.227***	0.180***
	Drive to continue with gambling after winning a large sum of money					0.147***	0.144***
6	Mean frequency of gambling						0.134***
	Total model						
	R	0.340	0.382	0.417	0.595	0.642	0.651
	Adj. R^2	0.114	0.144	0.170	0.347	0.404	0.415
	ΔR^2	0.116***	0.030***	0.028***	0.180***	0.059***	0.011***

β, standardized beta coefficient; R, multiple correlation coefficient; Adj. R^2*, the adjusted coefficient of determination;* ΔR^2*,* R^2 *change; *p < 0.050; **p < 0.010; ***p < 0.001.*

predictors, except for cognitive distortions, remained significant in the last step. Girls with higher levels of risk and delinquent behavior suffer from more adverse gambling consequences, and so do girls who surround themselves with close friends who gamble often. Girls with more gambling related cognitive distortions such as incorrect understanding of probability and chance, more superstitious beliefs, and higher illusion of control all exhibit more adverse gambling consequences. However, specific motives for gambling were the most potent individual predictors of adverse consequences (explaining almost 20% of the entire variance by themselves). Thus, when we entered them into the analysis, cognitive distortions lost their predictive strength. Out of the four motives, specific motivation to earn money by gambling, and to become better at gambling, as well as to gamble in order to relax, proved to be significant individual predictors. Motivation to feel better was not a significant predictor of adverse gambling consequences. As expected, those who had more experience winning large sums of money (according to their own subjective feeling of what a large sum of money is) and those with the drive to continue gambling while winning also experience more adverse gambling consequences, and so do girls who gamble more often.

DISCUSSION

Findings on gambling participation of Croatian adolescent girls show that, just like in other countries, girls in Croatia are involved in gambling activities, and part of them develop gambling related problems. However, it seems that girls have somewhat different preferences compared to boys. Most girls in our sample play lotto and scratch cards. This confirms findings from other studies showing that lotto and scratch cards seem to be the preferred games of choice among adolescent girls (Gupta and Derevensky, 1998; Volberg, 1998; Jacobs, 2000; Stinchfield, 2000; Felsher et al., 2004; Ellenbogen et al., 2007; Kristiansen and Jensen, 2014; Elton-Marshall et al., 2016). In contrast, adolescent boys prefer sports betting, slot machines and virtual betting, both in Croatia (Ricijas et al., 2016b) and in other countries (Felsher et al., 2004; Ellenbogen et al., 2007; Kristiansen and Jensen, 2014; Elton-Marshall et al., 2016). This difference in gaming preferences helps explain stark differences in the prevalence of girl and boy problem gambling. Slot machines and sports betting are games characterized by high event frequency, "near misses" and perceived elements of knowledge/skills and have been found to be especially risky and associated with problem gambling (Griffiths, 2000; Reith, 2006). With this regard lotto and scratch cards seem to have a lower addictive potential, although their potential adverse consequences should not be ignored. They provide a window into gambling life for adolescent girls, and can spark their curiosity for other gambling activities. At the same time people tend not to perceive them as potentially harmful and do not believe they can lead to problems, which is a myth (Ariyabuddhiphongs, 2011). In reality, there are cases of scratch-cards gambling disorders (Raposo-Lima et al., 2015). Moreover, some authors argue that scratch cards, with their potential high event frequency, also have addictive potential, and go so far as to calling them "paper slot machines" (Griffiths, 2005). Given these findings it would be wrong to conclude that girls playing

lotto and scratch cards are not at any risk to develop gambling problems.

Percentages of girls who gamble regularly (once a week or more often) are rather low, especially when compared to their male counterparts in Croatia (Ricijas et al., 2016b). However, a bit over 7% of girls can be viewed as regular gamblers, which is a number roughly comparable to other countries (Shapira et al., 2002; Johansson and Götestam, 2003; Olason et al., 2006; Skokauskas and Satkeviciute, 2007). These numbers are not surprising given the Croatian liberal gambling market. In spite of gambling being illegal for minors (adolescents younger than 18) a high number of gambling venues in Croatia remain both available and accessible to teens (Ricijas et al., 2016b).

Moreover, 3% of girls regularly bet on sports, and among the games that are played regularly sports betting is just as common as lotto and scratch cards. It is interesting how, compared to adult women who seem to prefer slot machines over other gambling activities (Hing and Breen, 2001; Potenza et al., 2001; Holdsworth et al., 2012), this type of game is not widespread among Croatian adolescent girls. Although when both regular and occasional gambling on slot machines is taken into account, numbers of girl gamblers who like this activity is again rather high, especially when illegality of machines is considered.

Prevalence rates in our sample confirm that numbers of at-risk and problem gamblers among girls are substantial. Among the entire sample, almost 2% of girls are already experiencing serious consequences because of their gambling (can be considered problem gamblers), and almost 7% are experiencing low to moderate consequences (at-risk gamblers). This data can be used as an indicator of general prevalence, however when we look only at those girls who have gambling experience, the numbers of at-risk (11.2%) and problem gamblers (3.2%) are more alarming and point to the necessity of prevention and treatment interventions efforts to be aimed at girls, just as well as at boys. Our data are roughly comparable to other studies (Hardoon et al., 2004; Ellenbogen et al., 2007; Donati et al., 2013; Lupu and Todirita, 2013; Kristiansen and Jensen, 2014), although one has to be very careful in this particular comparison because we used a different screening instrument to identify at-risk and problem gamblers.

Furthermore, girls with more severe gambling related consequences no longer prefer just one type of gambling activity, but are prone to play several games regularly (once a week or more often). In general, adolescent problem gamblers participate in more different gambling activities than non-risk gamblers (Kristiansen and Jensen, 2014), and our data shows adolescent girls also follow this trend.

Most interestingly, although lotto and scratch cards seem to be the preferred games of choice for adolescent girls overall, our findings are completely different when we look at preferences of girl problem gamblers. Here we see slot machines and sports betting to actually be the preferred games of choice. These findings are expected when the addictive potential of these types of activities is taken into account. Also, studies show that games most commonly played by adolescent problem gamblers are slot machines, sports betting and card games (see Calado et al., 2016 for review). With the exception of card games, which is not a common gambling activity in Croatia, neither for boys or girls (Dodig and Ricijas, 2011), Croatian girl problem gamblers seem to prefer the same games as boy problem gamblers.

Our second goal was to investigate the predictive power of different cognitive, motivational, social and behavioral factors for adolescent girls' problem gambling. Our results are mainly in line with other research investigating general problem gambling correlates among adolescents (Derevensky and Gilbeau, 2015) and confirm the importance of all these factors for girls. Girls who display higher levels of general risky and delinquent behavior also have more severe consequences because of their gambling. Our measure of risky behavior was rather comprehensive and included different behaviors such as stealing, vandalism, aggressive behavior, truancy, substance use etc. However, future studies might examine the importance of specific risky and delinquent behavior. If girl problem gamblers are to be differentiated between boy problem gamblers, it would probably be at the level of specific behaviors. For example, boys not only commit more delinquent and criminal acts, but are typically involved in more serious offenses (Zahn et al., 2010). It is possible that problem gambling among boys is tied to more serious delinquent behavior, while problem gambling among girls is more tied to risky behavior, especially in the school setting, as some authors seem to indicate (Casey et al., 2011).

Our finding that girls whose friends also participate in gambling activities already exhibit more severe gambling consequences and problems, is in line with research on boys (Ricijas et al., 2016a), with other studies of adolescent problem gambling (Delfabbro and Thrupp, 2003; Hardoon et al., 2004; Langhinrichsen-Rohling et al., 2004; Dickson et al., 2008), and with research showing that having friends who are also involved in risky and problem behavior increases the chances of the adolescent to also become problematic (Chassin et al., 2004; Gardner and Steinberg, 2005; Simons-Morton et al., 2005). However, our results are not in-line with Donati et al. (2013) study in which peer gambling involvement was not a significant predictor of girl problem gambling. Explanation of these different results probably lies in the different measures of peer involvement, and future studies should adopt similar, reliable and valid measures before firm conclusions about the role of peer involvement for girl problem gambling. Future studies might also want examine peer gambling more closely, specifically investigate characteristics of peer gamblers—are they also problem gamblers, or just occasional gamblers, what is their gender and are there gender differences in having same-sex vs. opposite sex peer gamblers. Moreover, gambling-related perceived norms have been linked to higher gambling involvement in previous studies (Foster et al., 2014; St-Pierre et al., 2015). However, we do not know if perceived norms and peer gambling influence the development of gambling related problems in the same way for girls and boys.

As expected, both cognitive and motivational factors play important roles in predicting girl problem gambling. When first added to the model, both types of cognitive distortions were significant. Girls with higher illusions of control, and those with poorer understanding of probabilities and higher levels of superstitious thinking, display more severe gambling consequences. This is in line with other research on adolescents

in general (Derevensky and Gilbeau, 2015), and in girls specifically (Donati et al., 2013). However, when motivational factors were added to the model cognitive factors were no longer significant. This is in accordance with numerous studies showing that cognitive and motivational factors are inextricably linked (Moore and Ohtsuka, 1999; Delfabbro et al., 2006; Marmurek et al., 2014), and that cognitive factors depend strongly on motivational factors (Thompson et al., 2007). A Croatian study which involved only adolescent boys showed similar results (Ricijas et al., 2016a).

Just like in the Ricijas et al. (2016a) study, findings on girls similarly show that motivational factors are the strongest predictors of problem gambling. Girls with a higher motivation to earn money, to be better at gambling and to relax, just like girls with more experiences of winning large sums of money and the drive to continue gambling after winning have more severe gambling consequences. On the other hand, the motive to feel better did not significantly predict girl problem gambling. To the best of our knowledge, ours is the first study to investigate different motives as predictors of girl problem gambling, and our results are mainly in line with studies showing these particular sets of motives to be especially salient among problem gamblers (Wood et al., 2004; Yip et al., 2011; Spurrier and Blaszczynski, 2014; Derevensky and Gilbeau, 2015; Hing et al., 2016).

However, they are in contrast with research on adults which shows that women gamble to alleviate their stress, loneliness and depression (Wenzel and Dahl, 2009), in other words in order to feel better. A number of studies on adult women and their motives was done on treatment samples, and it is reasonable to assume that our study involved mainly healthy and no-problem adolescent girls (as witnessed by levels of problem gambling and risky and delinquent behavior). Future studies might want to investigate gambling motivation among girls already being treated for gambling problems. The motive to feel better might be predominant among this specific population.

As expected from other studies, higher gambling frequency predicted more severe gambling consequences in girls, just like it predicts the same adverse consequences in boys (Ricijas et al., 2016a). Logically, those who gamble more frequently have more opportunities to experience both positive and negative outcomes of gambling involvement, which can then be associated with different psychological consequences and loss of control, disrupted peer and family relationships, as well as different financial consequences.

Each set of factors, when first introduced into our model, significantly improved prediction and added to the overall variance explained. This confirms that adverse gambling consequences depend on a complex set of factors, just like many other studies of gambling emphasize (Blaszczynski and Nower, 2002; Nower and Blaszczynski, 2004). On the other hand, considering the high number of predictors, the overall percentage of variance explained is rather low (just over 40%). Similar sets of factors in other studies, dominated by boys, explain larger percentages of variance (Clarke, 2004; Ricijas et al., 2016a). This probably means that although our study shows that girl problem gambling is predicted by largely the same factors as boy problem gambling, there might be other determinants not investigated here that are possibly girl specific and better capture adolescent girl gambling consequences. Therefore, and based on the findings of previous research, it would be interesting to explore the contribution of mental health issues (Potenza et al., 2001; Desai et al., 2005), childhood trauma (Petry and Steinberg, 2005), coping mechanisms (Afifi et al., 2010) and family influences (such as family functioning, mental health problems of family members, their gambling etc.; Hardoon et al., 2004; Langhinrichsen-Rohling et al., 2004; Chalmers and Willoughby, 2006; McComb and Sabiston, 2010).

Our study has several limitations that need to be taken into account. Firstly, our design was cross-sectional and we rely on self-reports, both of which limit our conclusions. Because of this, it is equally likely that all the examined factors lead to problem gambling, as it is likely that problematic gambling involvement leads to certain cognitions, motives, and behavior. Only future longitudinal studies can settle this issue. Our results are nevertheless important because they show the need to investigate girl problem gambling in more depth.

Moreover, our screening instrument was developed on both girls and boys, but there is no available data on its gender invariance. Since some other studies indicate that boys and girls might understand items in instruments differently, and question their validity for girls (Derevensky and Gupta, 2006; Rossow and Molde, 2006) this is another potential limitation of our study. However, we did use an instrument developed specifically for use on adolescents, which captures consequences linked to girl problem gambling in previous studies (Wiebe et al., 2000; Ellenbogen et al., 2007), which we believe to be one of the strengths of our study. Future research should test for gender invariance of the CAGI, and other commonly used screening instruments, in order to be able to reliably test for gender differences in adolescent problem gambling.

CONCLUSION

Although gambling participation and prevalence of problem gambling is more widespread among boys than girls worldwide (Calado et al., 2016), results of this study show that girls still gamble and develop gambling related consequences and problems. Our findings indicate that prevention efforts need to be aimed at girls just as much as at boys. One widely discussed question in planning prevention interventions is whether to employ any gender specific approach/strategy or focus on both boys and girls in the same manner (Blake et al., 2001; Rohrbach and Milam, 2006; Vigna-Taglianti et al., 2009). Our results indicate that universal youth gambling prevention programs (ones focused on general populations) might want to employ some gender specific strategies. Given the differences between the preferred games of choice among girls and boys (lotto and scratch cards vs. sports betting), universal programs should teach about perils of all these gambling activities if they want to be effective for both girls and boys.

However, our results also indicate that girls with gambling problems prefer games like slot machines and sports betting, which is a point of similarity between girls and boys. Our study

also shows adverse gambling consequences experienced by girls are predicted by a set of complex factors which include cognitive distortions, motives to earn money, be better at gambling and to relax, the experiences of winning large and the drive to continue gambling, together with social factors such as having friends who also gamble, being involved in other risky and delinquent behavior and higher gambling frequency. All these have been identified as risk factors of boys gambling in previous research (Derevensky and Gilbeau, 2015), and our findings confirm the relevance of the same risk factors for girl problem gambling.

Consequently, our findings show that youth gambling prevention programs at the indicated level (ones designed for populations at high risk and/or populations already exhibiting gambling related problems) should refrain from tailoring activities to be boy or girl specific. However, studies focusing on girl gamblers and girl specific predictors are still very scarce, and much future research is needed before firm conclusions on these issues can be drawn. For example, if girls really tend to exhibit a particularly complicated clinical picture characterized by high comorbidity with other mental health issues (Desai et al., 2005), indicated prevention programs than need to take this gender specificity into account. More longitudinal studies are needed in order to reach reliable conclusions on any gender specific risk and protective factors of adolescent problem gambling.

ETHICS STATEMENT

The study was carried out in accordance with the latest version of the Declaration of Helsinki and the Croatian Code of Ethics for Research with Children (Ajdukovic and Kolesaric, 2003). The Ethics Committee of the Faculty of Education and Rehabilitation Sciences (University of Zagreb) approved the study and a written support from Croatian Ministry of Education, Science, and Sport and Croatian Teacher Training Agency was received. According to the Croatian Code of Ethics for Research with Children (Ajdukovic and Kolesaric, 2003) all participants who are older than 14 (as in this study) can give their own personal written or oral consent to participate in a study (Article 3, paragraph 3.4). In accordance with the Code we informed all participants about the main aim of the study and their voluntary participation in it. Consent to participate was considered implicit by the return of the questionnaire, after the participants were fully informed about the study. Additionally, all participants gave their oral informed consent to participate. Students could decline participation at any point during instrument administration.

AUTHOR CONTRIBUTIONS

AH, DH, NR, and VK contributed to the study design, questionnaire development, administering, correcting, and entering questionnaires in the database. AH and DH were responsible for writing the introductory sections of the manuscript and prepared the article and all additional materials for submission. AH was responsible for statistical analysis. All authors contributed to the interpretation and discussion of the results. AH, DH, NR, and VK were responsible for the revision of the article and addressing the reviewer's comments and suggestions. All authors critically revised the work and approved the final version.

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The Blurred Future of Adolescent Gamblers: Impulsivity, Time Horizon, and Emotional Distress

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The main purpose of this study was to investigate the interplay of functional and dysfunctional impulsivity, delay discounting, time perspective, and emotional negative states on gambling severity in Italian adolescents. A second aim of the study was to analyze the developmental trajectories of gambling involvement, functional and dysfunctional impulsivity, delay discounting, consideration of future consequences, and negative affectivity in a cross-sectional perspective. One thousand and ten Italian adolescents aging between 12 and 19 years were administered the South Oaks Gambling Screen Revised for Adolescents (SOGS-RA), the Functional and Dysfunctional Impulsivity Scale (FDIS), the Monetary Choice Questionnaire (MCQ), the Consideration of Future Consequences Scale (CFC-14), and the Depression, Anxiety and Stress Scales-21 (DASS-21). Data analyses were conducted using correlational analysis, Chi-square test, analysis of variance, and hierarchical regression analysis. Results indicated that, relative to non-gamblers and non-problem gamblers, at-risk and problem gamblers showed higher levels of impulsivity, steeper delay discounting, shorter time horizon, and reported experiencing significantly higher levels of depression, anxiety, and stress. Results of hierarchical regression analysis, with SOGS-RA scores as the dependent variable, and gender, age, FDIS, MCQ, CFC-14, and DASS-21 scores as independent variables, indicated that, along with gender and age, low scores of future orientation and high scores of dysfunctional impulsivity, depression, anxiety, present orientation, and delay discounting significantly predicted gambling severity. These findings provide further evidence that the higher the gambling involvement, the greater the tendency to devalue delayed rewards and to focus on the immediate consequences of one's behavior. Interestingly, for the first time these results reveal an association between gambling severity and both dysfunctional impulsivity and negative affective states across adolescence. Finally, results of cross-sectional analyses suggest that gambling severity contributes more than age in shaping the developmental trajectories of functional and dysfunctional impulsivity, delay discounting, time perspective, and negative affective states.

Keywords: gambling, adolescence, impulsivity, delay discounting, temporal perspective, depression, anxiety, negative affect

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INTRODUCTION

In the last decades gambling addiction has become a serious public health issue. Mainly due to the increasing availability of online gambling and the similarity between modern forms of gambling and other familiar technology-based games, the prevalence of disordered gambling will predictably increase further in the near future (Donati et al., 2013; McCormack et al., 2014; Delfabbro et al., 2016). Recently, Gainsbury et al. (2016b) have demonstrated that for a large proportion of at-risk and problem gamblers the exposure and the engagement with social media advertisements for gambling worsened their problems (see also Gainsbury et al., 2016a).

In this backdrop, adolescent participation in gambling activities is of particular concern, given that some risk factors for disordered gambling are so manifest during adolescence, that adolescence by itself may be regarded as a risk factor for the onset and the development of problematic gambling (Messerlian et al., 2004, 2005; van den Bos et al., 2013).

Indeed, large-scale international prevalence surveys and meta-analytic studies have shown that 10–15% of adolescents are at risk for developing gambling problems and 3–8% can be considered having serious gambling problems (see Blinn-Pike et al., 2010; Ladouceur et al., 2013). A recent review on the prevalence of adolescent problem gambling across five continents reported that 0.2–12.3% of youth meet diagnostic criteria for problem gambling (Calado et al., 2016). In spite of gambling is an illegal activity in Italy under the age of 18, some studies on Italian adolescents have found that 16–17% of high school students were at-risk of developing problem gambling, and 7–8% problem gamblers (Chiesi et al., 2013; Cosenza et al., 2014; Cosenza and Nigro, 2015).

Even if studies on adolescent gambling increased in the last years, research on risk factors from early to late adolescent gambling remains very scarce. This is even more surprising since several studies have highlighted that adolescents represent a high vulnerable population and research has demonstrated that, other things being equal, severe gambling-related difficulties in adulthood steam from early gambling problems (Blinn-Pike et al., 2010; Volberg et al., 2010; Olason et al., 2011; Cosenza et al., 2014; Gupta and Derevensky, 2014).

While there are several potential factors leading to the onset and development of problematic gambling, the research on the identification of risk factors associated with youth disordered gambling is still limited in quantity (Shead et al., 2010; Scholes-Balog et al., 2014). Furthermore, to date the interplay of different risk factors on adolescent problem gambling has not been adequately taken into account (Cosenza and Nigro, 2015).

Although the etiology of gambling disorder is complex and multifaceted, several studies have identified impulsivity as the most robust characteristic associated with disordered gambling (MacKillop et al., 2014). Interestingly, prospective investigations have indicated that high impulsivity during early adolescence predicts later gambling problems (Pagani et al., 2010; Shenassa et al., 2012; Slutske et al., 2012).

Impulsivity describes a constellation of heterogeneous traits or behavioral dispositions that includes inability to take into account the future consequences of current behavior and the tendency to devalue delayed rewards. Acting without considering future consequences has been considered one of the potential determinants of impulsive behavior (Whiteside et al., 2005; see also Sharma et al., 2013). Likewise, delay discounting, that is the relative preference for small immediate rewards, has been considered a behavioral index of impulsivity (Ainslie, 1975; Madden et al., 2009; see also Amlung and MacKillop, 2011; Gray and MacKillop, 2014). Studies examining the relation between gambling and delay discounting among late adolescents indicated that, relative to non-problem gamblers, young problem gamblers more rapidly discounted delayed monetary outcomes (for exception see Holt et al., 2003; MacKillop et al., 2006; Cosenza and Nigro, 2015; Nigro and Cosenza, 2016).

The association between pathological gambling and shortened time horizon was first investigated by Hodgins and Engel (2002). Subsequent studies further supported the existence of a positive association between disordered gambling and insensitivity to future consequences among both adult (Toplak et al., 2007; MacLaren et al., 2012; Ciccarelli et al., 2016b) and adolescent gamblers (however, for different results, see MacKillop et al., 2006; Cosenza and Nigro, 2015; Cosenza et al., 2016).

Finally, as indicated by earlier studies, negative emotional states, such as depression, anxiety, and stress, are significant correlates of problematic gambling (Blaszczynski and McConaghy, 1989; Coman et al., 1997; Blaszczynski and Nower, 2002; El-Guebaly et al., 2006; Kim et al., 2006; Ladouceur et al., 2006; Johansson et al., 2009; Barrault and Varescon, 2013; Lorains et al., 2014; Dowling et al., 2015; Raylu et al., 2016; Toneatto and Pillai, 2016). In particular, some epidemiological studies indicated that problematic gambling is often associated with mood disorders (Griffiths, 1995; see also Lorains et al., 2011), as well as that pathological gamblers in treatment frequently suffer from clinical depression (i. e., Ladouceur et al., 2006). Nower and Blaszczynski (2010) hypothesized that gambling contributes to alleviate negative emotional states or boredom (Wulfert et al., 2005; Wood and Griffiths, 2007; see also Stewart et al., 2008), whereas Gee et al. (2005) observed that gambling increases anxiety.

From the few studies investigating the co-occurrence of negative affects and gambling in adolescence emerged that, relative to both non-gamblers and social gamblers, adolescent problem gamblers have higher rates of depression, females have significantly higher rates of depression than males, and older adolescents score higher than younger (Nower et al., 2004). Furthermore, compared to non-gamblers, social and at-risk gamblers, adolescent problematic gamblers report higher level of both state and trait anxiety and social stress, with females obtaining higher scores than males (Ste-Marie et al., 2006). In a sample of young online gamblers Matthews et al. (2009) found that problem gambling was significantly predicted not only by negative mood states after gambling, but also by negative mood states in general. More recently, in a longitudinal study involving adolescents and early adults, Dussault et al. (2011) demonstrated that the association between depression and problematic gambling in adolescence steams mainly from impulsivity. In addition, the mechanisms explaining

the association between the two disorders vary as a function of developmental stages.

Although evidences from previous research support the idea that there could be a complex interplay among problematic gambling, impulsivity, "myopia for the future," and negative emotional states in adolescence, to date no study has ever examined the interrelationship among these variables all together.

The main aim of the present study was to investigate the interplay among impulsivity, delay discounting, time perspective, and negative affectivity in a large sample of adolescents aging between 12 and 19 years. A second aim of the present study was to analyze the developmental trajectories of gambling involvement, functional and dysfunctional impulsivity, delay discounting, consideration of future consequences, and negative affectivity in a cross-sectional perspective.

In line with previous research on both adults and adolescents, it was expected that female adolescents would be less likely to report gambling-related problems than male adolescents. Moreover, it was hypothesized that the more severe the gambling involvement is, the higher the level of impulsivity, the steeper the delay discounting rates, and the shorter the time horizon are. Finally, it was also hypothesized that, relative to other groups, at-risk and problem gamblers would show more severe depression, anxiety, and stress symptoms.

METHODS

Participants

One thousand and ten Italian students (47,5% males) aged between 12 and 19 years (Mean age = 15.37 years; *SD* = 2.05) attending public middle (14.2%) or high school (58.4% lyceum and 27.4% technical and trade school) in Southern Italy took part in the study. They were administered the South Oaks Gambling Screen Revised for Adolescents (Winters et al., 1993, 1995; Italian version: Colasante et al., 2013; SOGS-RA), the Functional and Dysfunctional Impulsivity Scale (FDIS; Dickman, 1990), the Monetary Choice Questionnaire (Kirby and Marakovic, 1996; Kirby et al., 1999; MCQ), the Consideration of Future Consequences Scale (Joireman et al., 2012; Italian validation: Nigro et al., 2016; CFC-14), and the Depression, Anxiety and Stress Scales-21 (Lovibond and Lovibond, 1995; Italian validation: Bottesi et al., 2015; DASS-21). Participants did not receive anything for participating in the study. The authors administered the questionnaires. For each measure participants received detailed written instructions. Participants were allowed to ask any questions about the questionnaires, if any.

Measures

Adolescent gambling behavior was measured through the SOGS-RA, the most widespread self- report instrument for assessing the prevalence of problem gambling in adolescence. The questionnaire is made up of 12 scored items measuring gambling behavior and gambling-related problems during the past 12 months. The total score ranges from a minimum of 0 to a maximum of 12. The un-scored SOGS-RA items request participants to indicate, among others, the frequency of participation in different gambling activities, the largest amount of money gambled in 1 day, and parental involvement in gambling. In addition, we asked participants to specify the primary motives for gambling from a list (Volberg, 1993). The Italian version of the SOGS-RA was found to have acceptable internal reliability ($\alpha = 0.78$; Colasante et al., 2013).

The FDIS is a 23 items self-report questionnaire assessing functional and dysfunctional impulsivity. The Functional Impulsivity scale (FI) consists of 11 items measuring the tendency to act quickly without planning when the situation demands it for personal gain. The Dysfunctional Impulsivity scale (DI) consists of 12 items assessing the tendency to engage in rapid, error-prone information processing in situations where slower methodical approaches are required. Respondents are asked to indicate the extent to which they agree with each statement on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In the present study, Cronbach's alpha for the functional and dysfunctional scales was 0.71 and 0.76, respectively.

The MCQ is a measure of delayed reward discounting that presents participants with 27 hypothetical choices between a smaller reward available immediately, and a larger reward available at some point in the future, with delays ranging from 7 to 186 days. The 27 items are grouped into three categories on the basis of the approximate magnitudes of the delayed rewards. The three levels of magnitude are: small ($25–$35), medium ($50–$60), and large ($75–$85). Participants are instructed to respond in the same manner as they would with real money. The pattern of responding can be used to determine an estimate of the participant's overall discounting rate parameter (*k*), as well as temporal discounting of rewards at the three different levels of magnitude (*k* small, *k* medium, and *k* large). The higher the *k*-values, the greater the proportion of choices for the smaller immediate monetary rewards. Calculating separate discount rates for each level of magnitude allows estimating the magnitude effect on discount rates, i. e., the tendency for discount rates to decrease as a function of reward level (Green et al., 1981).

The CFC-14 is a 14-item scale that was developed to measure individual differences in the extent to which people evaluate the immediate as opposed to distant implications of current behaviors and events. Responses are made with a 7-point Likert scale ranging from 1 (*extremely uncharacteristic of me*) to 7 (*extremely characteristic of me*). The CFC-14 is a two factors scale with two dimensions, one assessing consideration of immediate consequences (CFC-I), the other tapping consideration of future consequences (CFC-F). The Cronbach's alphas for the Immediate and Future scales were 0.84 and 0.83, respectively, in a large sample of Italian adolescents (Nigro et al., 2016).

The DASS-21 is a self-report measure assessing three related negative affective states, namely depression, anxiety, and stress. The Depression scale comprises items that assess symptoms characteristically associated with dysphoric mood, such as sadness, worthlessness, lack of interest or involvement, and low self-esteem. The Anxiety scale taps signs of physical arousal, symptoms of panic attacks, as well as subjective experience of fear. The Stress scale assesses symptoms, such as difficulty relaxing, impatience, and being easily upset, irritable, or

overreactive. Respondents are asked to indicate how much each statement applied to them during the previous week on a 4-point Likert scale ranging from 0 to 3. Higher scores indicate severe emotional distress. Cronbach's alphas were, respectively, 0.82 for the depression subscale, 0.74 for the anxiety dimension, 0.85 for the stress subscale, and 0.90 for the full scale (Bottesi et al., 2015).

Procedure

The study was approved by the Ethics Committee of the Department of Psychology of the Second University of Naples. Prior to participation, all participants gave written informed consent. For minors, informed consent was obtained from parents. Participants were tested in groups of 10 to 20 at a time in a quiet room in school. Administration of all instruments required from 20 to 30 min.

Statistical Analyses

Data were analyzed with the IBM Statistical Package for the Social Sciences, version 20.0. The alpha significance level was set at $p < 0.05$. All variables were initially screened for missing data, distribution abnormalities, and outliers (Tabachnick and Fidell, 2013). Minor missing data (<2%) for all variables were replaced with means. Responses from the MCQ were analyzed using the approach described by Kirby et al. (1999). Because the *k*-values were positively skewed, a natural log transformation was conducted and used for all analyses. Furthermore, given that the distribution of the SOGS-RA was positively skewed, square root transformation was performed on this variable so that assumptions of normality, linearity and homoscedasticity had been adequately met.

Pearson correlation co-efficients and partial correlations were calculated to examine the relationships among the study variables. For categorical data differences in percentages were compared with the Chi-square test. Univariate and mixed-model ANOVAs were used to assess mean differences on continuous variables. *Post hoc* single comparisons were performed using two-tailed *t*-tests for dependent groups with Bonferroni correction for multiple comparisons ($p < 0.05$). The magnitude effect on the discounting task was examined using paired samples *t*-test. Finally, to reveal potential predictors of gambling behavior and gambling-related problems, we performed a hierarchical regression analysis with SOGS-RA scores as the dependent variable, and gender, age, FDIS, MCQ, CFC-14, and DASS-21 scores as independent variables. In order to control for the presence of multicollinearity, before interpreting the regression coefficients, we calculated the variance inflation factors (VIF), which were below the recommended cutoff of 10 (max. VIF = 1.876; Ryan, 1997).

RESULTS

The associations among variables were assessed first using Pearson's correlation coefficients. Subsequently, we tested for gender differences through univariate analyses of variance (ANOVAs). Results showed significant gender differences on the SOGS-RA, the FDIS Functional Impulsivity dimension, the three discounting rates of the MCQ, the CFC-14 Immediate subscale, with males outperforming females, and on the three dimensions of the DASS-21, with females scoring higher than males. Since age was positively correlated with SOGS-RA, MCQ, and DASS-21 scores, to ascertain whether the measures correlated even after controlling for gender and age, partial correlations among the measures were calculated (see **Table 1**).

As **Table 1** shows, correlations between SOGS-RA, FDIS, MCQ, CFC-14, and DASS-21 scores were moderate to strong in strength.

In accordance with Winters et al.'s original SOGS-RA scoring system (1993, 1995), respondents were classified in the following four categories: *non-gamblers*, that includes individuals who

TABLE 1 | Partial correlations among all variables controlling for gender and age.

	2	3	4	5	6	7	8	9	10	11
1. SOGS-RA	0.079*	0.341**	0.111**	0.108**	0.136**	0.243**	−0.207**	0.279**	0.273**	0.271**
FDIS										
2. Functional Impulsivity		0.279**	0.038	−0.012	0.012	0.157**	−0.056	−0.047	−0.038	0.037
3. Dysfunctional Impulsivity		–	0.030	0.054	0.059	0.366**	−0.224**	0.253**	0.229**	0.275**
MCQ										
4. *k* small			–	0.592**	0.526**	0.110**	−0.062	−0.014	0.031	0.047
5. *k* medium				–	0.645**	0.074*	−0.057	0.020	0.069*	0.059
6. *k* large					–	0.069*	−0.097**	0.049	0.077*	0.064*
CFC-14										
7. Immediate						–	0.031	0.185**	0.186**	0.203**
8. Future							–	0.019	0.013	0.039
DASS-21										
9. Depression								–	0.666**	0.713**
10. Anxiety									–	0.673**
11. Stress										–

*$p < 0.05$; **$p < 0.01$.

reported no past year gambling, *non-problem gamblers* (score of 0–1), *at-risk gamblers* (score between 2 and 3), and *problem gamblers* (score of 4 or more). Of the total sample, 21.6% were screened as non-gamblers, 51.5% as non-problem gamblers, 19% as at-risk gamblers, and 7.9% as problem gamblers. The percentages of common gambling activities as a function of the relative frequency of participation in each activity during the last twelve months are reported in **Table 2**. As regards the amount of money invested in a single episode of play results indicated that 15.3% of at-risk and problem gamblers spent 1 Euro or less, 62.6% between 1 and 10 Euros, 15.7% between 10 and 50 Euros, 3.8% between 50 and 100 Euros, and 2.7% more than 100 Euros.

In order to determine whether gambling activities varied as a function of gender and age, after collapsing gambling activities in three main categories, namely "offline games only" (74% of participants), "online games only" (1% of participants), "both offline and online games" (25% of participants), data were submitted to Chi-square analyses. Non-gamblers and 23 participants who did not specify the gambling activities in which they engaged were excluded from analyses. Chi-square test revealed no significant differences due to gender (χ^2 (2, N = 769) = 5.87; p =.053), nor to age (χ^2 (14, N = 769) = 10.51; $p = 0.724$).

Chi-square test was also used to ascertain whether there was an association between severity of gambling involvement and each motive for gambling. Obviously, participants who reported no past year gambling (non-gamblers) were excluded from analysis. Results indicated that at-risk and problem gamblers gamble significantly more to win money (χ^2 (2, N = 792) = 27.99; $p < 0.001$), for excitement or as a challenge (χ^2 (2, N = 792) = 17.39; $p < 0.001$), to socialize (χ^2 (2, $N = 792$) = 13.64; $p < 0.01$), and for fun or entertainment (χ^2 (2, $N = 792$) = 8.45; $p < 0.05$).

Group differences on the FDIS, the MCQ, the CFC-14 scales, and on the DASS-21 scores were tested using mixed model ANOVAs. Gender and age were included as covariates in the analyses. Results of 4 × 2 repeated measures ANOVA, with SOGS-RA group as a between-subjects factor and scores on the two FDIS scales, yielded a significant main effect of SOGS-RA group [$F_{(3,\ 1004)} = 32.12$; $p < 0.001$; $\eta_p^2 = 0.088$]. Furthermore, within-subjects contrasts revealed significant interaction effects between FDIS dimensions and gender [$F_{(1,\ 1004)} = 55.20$; $p < 0.001$; $\eta_p^2 = 0.052$], age [$F_{(1,\ 1004)} = 6.67$; $p < 0.01$; $\eta_p^2 = 0.007$], and SOGS-RA classification [$F_{(3,\ 1004)} = 22.19$; $p < 0.001$; $\eta_p^2 = 0.062$). Over and above gender and age effects, these results indicated that, in general, at-risk and problem gamblers were more impulsive than non-gamblers and non-problem gamblers. Of interest, non-gamblers and non-problem gamblers scored significantly higher on the functional scale than on the dysfunctional one, whereas at-risk and problem gamblers scored significantly lower on the functional impulsivity scale than on the dysfunctional impulsivity dimension.

As regards delay discounting performance, all participants showed higher k-values for smaller, compared to larger delayed rewards. All pair-wise differences in k between reward magnitudes were highly reliable overall and within the four groups (all $ps < 0.001$).

Choice behavior was analyzed using a 4 × 3 mixed-model ANOVA of group by magnitude (small, medium, and large). The analysis yielded significant main effects due to gender [$F_{(1,\ 1004)} = 9.38$; $p < 0.01$; $\eta_p^2 = 0.009$], age [$F_{(1,\ 1004)} = 18.42$; $p < 0.001$; η_p^2 =.018], and group [$F_{(3,\ 1004)} = 5.32$; $p < 0.01$; $\eta_p^2 = 0.016$], indicating that males scored higher than females on the MCQ, delay discounting become steeper as a function of age, and at-risk and problem gamblers showed higher rates of delay discounting than did non-gamblers and non-problem gamblers.

Regarding CFC-14 scores, results of a 4 × 2 repeated measures ANOVA yielded a significant main effect of gender ($F_{(1,\ 1004)} = 7.69$; $p < 0.01$; $\eta_p^2 = 0.008$], with males reporting higher scores on the Immediate subscale than females, as well as an interaction effect between SOGS-RA group and the two dimensions of the CFC-14 [$F_{(3,\ 1004)} = 30.27$; $p < 0.001$; $\eta_p^2 = 0.083$], indicating that Immediate scores increase as a function of gambling severity, whereas Future scores decrease according to gambling involvement.

A 4 × 3 repeated measures ANOVA was also conducted on DASS-21 scores. Results indicated significant main effects due to gender [$F_{(1,\ 1004)} = 41.04$; $p < 0.001$; $\eta_p^2 = 0.039$] and SOGS-RA group [$F_{(3,\ 1004)} = 31.39$; $p < 0.001$; $\eta_p^2 = 0.086$], showing that females scored significantly higher than males on the three DASS-21 dimensions, and that negative emotional states increase as a function of gambling severity.

Means and standard deviations by SOGS-RA group are presented in **Table 3**. To facilitate interpretation, descriptive statistics are reported for the untransformed variables.

To identify the potential predictors of gambling behavior and gambling-related problems, gender, age and scores on FDIS, MCQ, CFC-14, and DASS-21 scales were input to a multiple regression analysis with SOGS-RA scores as the dependent measure. Results of hierarchical regression analysis (see **Table 4**) showed that, along with gender and age, dysfunctional impulsivity, anxiety, depression, short time horizon, and delay discounting significantly predicted gambling severity. The overall model explained about a third part of the total variance of the SOGS-RA [$R^2_{adj} = 0.273$; $F_{(8,\ 1001)} = 48.35$; $p < 0.001$].

TABLE 2 | Percentages of common gambling activities as a function of frequency (12-months-prevalence).

	Never	Less than monthly	Monthly	Weekly	Daily
Cards	27.05	63.99	20.14	10.52	5.35
Horse or dog races	89.60	4.16	2.34	2.73	1.17
Sports betting	43.56	17.95	9.23	23.28	5.98
Dice	91.42	7.02	1.30	0.13	0.13
Casino	94.80	4.03	1.04	0.13	0.00
Scratch cards	51.63	33.03	9.62	5.07	0.65
Lotteries	76.98	17.04	4.68	1.04	0.26
Bingo	84.79	11.44	2.99	0.65	0.13
Slot machines	89.08	6.76	2.86	0.65	0.65
Skill games	71.91	15.60	5.59	4.55	2.34

TABLE 3 | Means and standard deviations by SOGS-RA groups.

	Non-gamblers		Non-problem gamblers		At-risk gamblers		Problem gamblers		Total sample	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***
FDIS										
Functional Impulsivity	30.15	6.07	31.52	5.94	32.46	6.84	33.69	6.43	31.57	6.25
Dysfunctional Impulsivity	28.68	6.75	30.12	6.87	34.10	7.01	36.71	7.58	31.09	7.34
MCQ										
k Total score (overall *k*)	0.02	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.02	0.02
k Small	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.04	0.05
k Medium	0.02	0.03	0.03	0.03	0.03	0.04	0.05	0.06	0.03	0.03
k Large	0.01	0.01	0.02	0.02	0.02	0.04	0.03	0.04	0.02	0.03
CFC-14										
Total score	4.88	0.58	4.76	0.66	4.46	0.78	4.11	0.90	4.68	0.72
Immediate	19.86	6.30	20.41	6.39	22.96	7.54	25.13	8.52	21.15	6.97
Future	32.17	6.85	31.03	6.94	29.46	8.74	26.60	8.01	30.63	7.52
DASS-21										
Total score	14.79	11.16	18.83	12.42	22.24	13.63	27.75	14.54	19.31	13.03
Depression	4.97	4.43	6.14	4.76	7.46	5.36	9.30	5.51	6.39	5.01
Anxiety	4.29	4.05	4.95	4.40	6.14	4.70	7.94	5.40	5.27	4.57
Stress	5.53	4.37	7.74	4.91	8.65	5.10	10.51	5.37	7.65	5.05

Descriptive statistics are reported for the untransformed variables.

Finally, to analyze the developmental trajectories of gambling involvement, trait impulsivity, delay discounting, time perspective, and negative affective states, participants were divided into four age-groups (12–13, 14–15, 16–17, and 18–19 years, respectively). Subsequently, SOGS-RA scores across age-groups were analyzed by means of univariate ANOVA, whereas scores on the FDIS, MCQ, CFC-14, and DASS-21 subscales (within-participants variables) were submitted to repeated measures ANOVAs followed by Bonferroni *post-hoc* test, with gender, age group, and SOGS-RA classification as between-participants variables.

As far as SOGS-RA scores, a 2 (gender) × 4 (age group) ANOVA yielded significant main effects of gender [$F_{(1,\ 1002)} = 77.66$; $p < 0.001$; $\eta_p^2 = 0.072$] and age group [$F_{(3,\ 1002)} = 8.24$; $p < 0.001$; $\eta_p^2 = 0.024$], showing that gambling severity varies as a function of gender, with males reporting higher scores than females, and increases progressively with age (see **Figure 1**).

In regard to functional and dysfunctional impulsivity, mixed model ANOVA, with gender, age group, and SOGS-RA group entered as between-subjects factors, and FDIS subscales as within-subjects factor, yielded a main effect due to SOGS-RA classification [$F_{(3,\ 979)} = 21.37$; $p < 0.001$; $\eta_p^2 = 0.061$], indicating that both functional and dysfunctional impulsivity increased as a function of gambling severity. Furthermore, analysis yielded a significant interaction effect between gender and SOGS-RA classification [$F_{(3,\ 979)} = 2.97$; $p < 0.05$; $\eta_p^2 = 0.009$], revealing that among non-gamblers females were less impulsive than males, whereas among problem gamblers females were more impulsive than males.

With regard to delay discounting, repeated measures ANOVA showed significant main effects of age group [$F_{(3,\ 979)} = 4.30$; $p < 0.01$; $\eta_p^2 = 0.013$] and SOGS-RA group [$F_{(3,\ 979)} = 2.81$; $p < 0.05$; $\eta_p^2 = 0.009$], indicating that scores increased with age and as a function of gambling severity.

With respect to time perspective, no significant between-subjects effect was observed. However, within-subjects contrasts revealed a significant interaction of CFC-14 scores and SOGS-RA classification [$F_{(1,\ 979)} = 15.35$; $p < 0.001$; $\eta_p^2 = 0.045$], reflecting the fact that Immediate scores increased, whereas Future scores decreased according to gambling severity.

As far as negative affectivity, mixed-model ANOVA identified significant main effects of gender [$F_{(1,\ 979)} = 9.27$; $p < 0.01$; $\eta_p^2 = 0.009$], with females obtaining higher DASS-21 scores than males, and SOGS-RA classification [$F_{(3,\ 979)} = 18.44$; $p < 0.001$; $\eta_p^2 = 0.053$], indicating that negative emotional states increased as a function of gambling severity.

Taken together, these results indicated that gambling severity contributes more than age in shaping the developmental trajectories of functional and dysfunctional impulsivity, delay discounting, time perspective, and negative affective states.

DISCUSSION

The present study is the first research that analyzes the interplay of self-reported functional and dysfunctional impulsivity, delay discounting, time perspective, and emotional negative states to gambling severity in adolescents. Previous research suggest the idea that problematic gambling, impulsivity, shortsightedness, and negative psychological states in adolescence are somewhat nested. However, and this is the novelty of our paper, to date no study had ever considered these constructs jointly.

TABLE 4 | Summary of hierarchical regression analysis.

Variable	B	R^2	ΔR^2	β	*t*	*p*	VIF
STEP 1							
Gender	−0.258	0.087	0.087	−0.270	−8.924	0.000	1.007
Age	0.034			0.145	4.792	0.000	1.007
STEP 2							
Gender	−0.267	0.193	0.106	−0.279	−9.827	0.000	1.008
Age	0.032			0.139	4.885	0.000	1.007
Dysfunctional Impulsivity	0.021			0.326	11.510	0.000	1.001
STEP 3							
Gender	−0.289	0.230	0.036	−0.302	−10.805	0.000	1.022
Age	0.030			0.129	4.637	0.000	1.010
Dysfunctional Impulsivity	0.018			0.281	9.880	0.000	1.057
DASS-21 Anxiety	0.021			0.198	6.893	0.000	1.076
STEP 4							
Gender	−0.289	0.250	0.020	−0.302	−10.920	0.000	1.022
Age	0.029			0.123	4.487	0.000	1.011
Dysfunctional Impulsivity	0.016			0.246	8.524	0.000	1.117
DASS-21 Anxiety	0.022			0.208	7.318	0.000	1.081
CFC-14 Future	−0.009			−0.146	−5.176	0.000	1.059
STEP 5							
Gender	−0.268	0.264	0.014	−0.281	−10.091	0.000	1.054
Age	0.030			0.127	4.663	0.000	1.012
Dysfunctional Impulsivity	0.013			00.199	6.492	0.000	1.278
DASS-21 Anxiety	0.020			0.195	6.880	0.000	1.093
CFC-14 Future	−0.010			−0.160	−5.701	0.000	1.074
CFC-14 Immediate	0.009			0.130	4.367	0.000	1.210
STEP 6							
Gender	−0.271	0.272	0.008	−0.283	−10.238	0.000	1.055
Age	0.028			0.120	4.414	0.000	1.018
Dysfunctional Impulsivity	0.012			0.186	6.052	0.000	1.299
DASS-21 Anxiety	0.012			0.115	3.146	0.000	1.853
CFC-14 Future	−0.010			−0.164	−5.873	0.000	1.076
CFC-14 Immediate	0.009			0.127	4.273	0.000	1.212
DASS-21 Depression	0.012			0.125	3.382	0.001	1.876
STEP 7							
Gender	−0.260	0.280	0.008	−0.272	−9.808	0.000	1.071
Age	0.025			0.105	3.840	0.000	1.047
Dysfunctional Impulsivity	0.012			0.186	6.100	0.000	1.299
DASS-21 Anxiety	0.011			0.108	2.939	0.003	1.862
CFC-14 Future	−0.010			−0.156	−5.600	0.000	1.084
CFC-14 Immediate	0.008			0.118	3.984	0.000	1.222
DASS-21 Depression	0.012			0.129	3.521	0.000	1.879
k Total score	0.037			0.090	3.236	0.001	1.066

B, unstandardized coefficient; ΔR^2, R square change; β, standardized regression coefficient; VIF, variance inflation factor.

On the whole, data from this study indicated that, relative to non-gamblers and non-problem gamblers, at-risk and problem gamblers showed higher levels of impulsivity, steeper delay discounting, shorter time horizon, and reported experiencing significantly higher levels of depression, anxiety, and stress.

In line with previous studies (van den Bos et al., 2013; Scholes-Balog et al., 2014; Welte et al., 2015; Raylu et al., 2016; for reviews see also Johansson et al., 2009; Griffiths, 2011; Donati et al., 2013), gender showed a significant negative relationship with SOGS-RA scores. However, no gender difference was observed with respect to the modes of gambling activities (offline vs. online). Interestingly, gambling routes did not vary as a function of age. Generally speaking, notwithstanding the advent of internet gambling, participants appeared to prefer traditional routes of gambling, probably because online gambling requires a credit card. However, especially striking is the amount of time and money spent on gambling activities. Just consider that a quarter of adolescent problem gamblers reported wasting between 10 and 50 Euros, and 14.5% of them more than 50 Euros in one day. In our opinion, future research should ask participants how they raise funds.

As far as impulsivity, results further support previous studies demonstrating that impulsivity, apart from the instruments used to asses it, remains one of the most robust feature associated with disordered gambling (MacKillop et al., 2014). What we first observed on adolescents dovetails with Maccallum et al. (2007), who found that, compared to normative data, adult pathological gamblers seeking treatment reported higher scores on both functional and dysfunctional impulsivity. More interestingly, our results showed that only dysfunctional impulsivity represents a significant predictor of severity of adolescent gambling involvement.

As regards to delay discounting, the results are in accordance with previous research demonstrating that pathological gamblers devalue or discount delayed rewards to a greater extent than non-gamblers and non-problem gamblers do (Petry and Casarella, 1999; e.g., Alessi and Petry, 2003; Madden et al., 2011; Michalczuk et al., 2011; Brevers et al., 2012; Miedl et al., 2012; Petry, 2012; Kräplin et al., 2014; see also Gray and MacKillop, 2014; Cosenza and Nigro, 2015; for a review see Wiehler and Peters, 2015; Cosenza et al., 2016; Nigro and Cosenza, 2016; Ciccarelli et al., 2016b).

In light of our results, adolescent gamblers show a similar shortsightedness by ignoring the future consequences of their actual behavior. More specifically, at-risk and problem gamblers appear to be more prone to focus on the immediate outcomes of their behavior than both non-gamblers and non-problem gamblers. This finding extends evidence obtained on both adult and adolescent samples (Hodgins and Engel, 2002; Whiteside et al., 2005; Toplak et al., 2007; Daugherty and Brase, 2010; MacLaren et al., 2012; Cosenza et al., 2014, 2016; MacKillop et al., 2014; Cosenza and Nigro, 2015; Ciccarelli et al., 2016a).

Since dysfunctional impulsivity was found to be strongly associated with the tendency to ignore hard facts when making decision (Dickman, 1990), it is no wonder that there are significant correlations among SOGS-RA, FDIS, and both CFC-14 and MCQ scores. It may be that high levels of

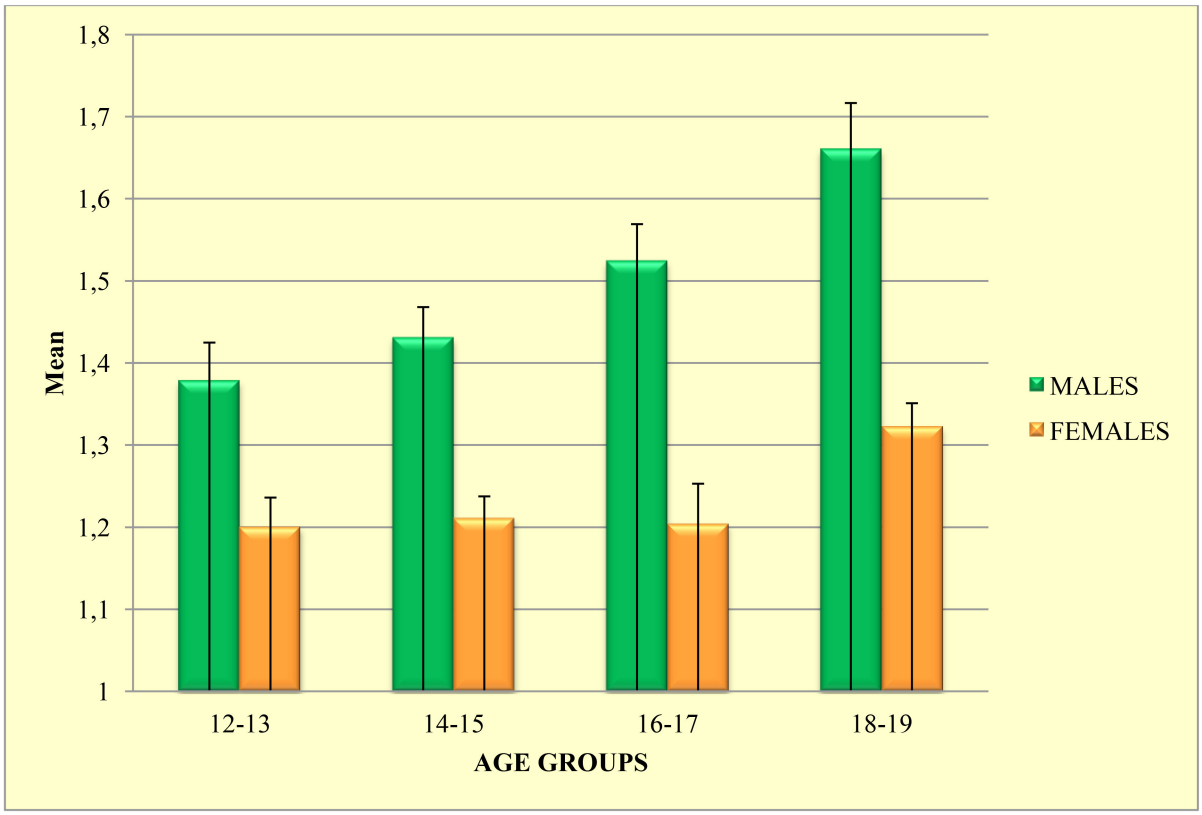

FIGURE 1 | SOGS-RA mean scores as a function of gender and age. Error bars indicate standard error of the mean.

dysfunctional impulsivity exacerbate the individual's inability to consider carefully the long-term future consequences of actions and to pay attention to one's own future, with all these impulsivity facets concurring to foster gambling addiction.

As with previous research (Lee et al., 2011; Hartmann and Blaszczynski, 2016; for reviews see Ciccarelli et al., 2017), the present study found that the more individuals have a problematic gambling involvement, the more they experience anxiety and depression. These results confirm the findings of previous studies demonstrating that among both adolescents and adults anxiety and depression co-occur with problematic gambling (Blaszczynski and McConaghy, 1989; Coman et al., 1997; Raylu and Oei, 2002; Kim et al., 2006; Barrault and Varescon, 2013; Martin et al., 2014; Estevez et al., 2015; Chinneck et al., 2016; Cunningham et al., 2016; Toneatto and Pillai, 2016; see also, Takamatsu et al., 2016). It may be that depression foregoes problem gambling, which serves to relieve negative emotions and to avoid problems (Blaszczynski and Nower, 2002) or that problematic gambling involvement increasingly leads to depressive symptoms due to the consequent social isolation and money problems (Dussault et al., 2011). Although it is difficult to determine whether anxiety and depression are primary, secondary, or concurrent with gambling, recently Raylu et al. (2016) have demonstrated that negative affectivity directly predicts gambling behavior.

Results of cross-sectional analyses indicated that gambling involvement increases as a function of gender and age. As depicted in **Figure 1**, the gambling involvement increases linearly with age among males, whereas among females the trend remains quite flat from 12 to 17 years, but picks significantly in late adolescence. This result corroborates the existence of a telescoping phenomenon, "whereby women as compared to men begin engagement in the behavior on average later in life than do men but the time between initial participation and development of a problem is shorter (or telescoped) in women as compared to men" (Potenza, 2013, p. S26).

As far as impulsivity, results indicated that the developmental trajectories of functional and dysfunctional impulsivity among adolescents are shaped mostly by the severity of gambling involvement. The same holds true for time perspective and delay discounting. Indeed, adolescent at-risk and problem gamblers appeared to devote less attention to the future, with more of the focus on the present (for similar results see Toplak et al., 2007; Cosenza and Nigro, 2015), and to have a weak orientation to the future also by choosing smaller but immediate rewards over larger but delayed rewards. Although some cross-sectional studies have demonstrated that in healthy adolescents delay discounting slightly declines in late adolescence (e.g., Green et al., 1994; Olson et al., 2007; Steinberg et al., 2009; see Albert and Steinberg, 2011 for a review), the results of cross-sectional

analysis might suggest that gambling severity put the positive age-related changes across adolescence almost in the shade.

Finally, the results indicate that negative psychological states, namely anxiety and depression, increase as a function of gender and gambling involvement. These findings further support previous research reporting a stronger association between gambling severity and both depression and anxiety disorders in women than in men (Getty et al., 2000; Petry et al., 2005; Ste-Marie et al., 2006; Kessler et al., 2008; e.g., Desai and Potenza, 2008; Williams et al., 2012; see also Cunningham et al., 2016).

Given that anxiety and depression have been considered both precursors and consequences of problem gambling (see Hartmann and Blaszczynski, 2016), having found that female adolescents reported significantly greater levels of anxiety and depression suggests that gambling research, prevention, and treatment programs should consider carefully gender differences. In addition, since the combination of high impulsivity and emotional vulnerability contributes to foster the cycle of pathological gambling (e.g., McCormick et al., 1984), treatment protocols for gambling disorder should also take in account this underlying interplay. Indeed, as stressed by Blaszczynski and Nower (2002) and Hartmann and Blaszczynski (2016), the co-occurrence of emotional vulnerability and problematic gambling makes treatment more difficult. If this is true for adults, it is especially true for adolescents.

LIMITATIONS

Although there are several strengths of the present study, including the large sample of participants, there are some limitations that should be considered when interpreting the present results. First, the current data are mainly based on self-report measures. In addition, it is to bear in mind that some authors questioned the validity of SOGS-RA (see Stinchfield, 2010 for a review), whereas other authors support the suitability of the instrument as a screening tool in adolescent populations (see Chiesi et al., 2013). Besides, it is worth to specify that the findings obtained are based on the general population of adolescents (12–19 years old), since no clinical group has been included in the study. Secondly, even if several studies demonstrated that there is no difference across hypothetical and potentially real rewards (e.g., Johnson and Bickel, 2002; Madden et al., 2003; Lagorio and Madden, 2005), delay discounting was evaluated using a behavioral measure that relies on hypothetical monetary choices. A final limitation is the use of cross-sectional sampling to analyze the developmental trajectories of gambling involvement, functional, and dysfunctional impulsivity, delay discounting, consideration of future consequences, and negative affectivity instead of a more appropriate longitudinal approach. Despite these limitations, to the authors' knowledge, the present study is the first to investigate the interplay of functional and dysfunctional impulsivity, time perspective, delay discounting, and negative affectivity on gambling severity among adolescents.

AUTHOR CONTRIBUTIONS

Authors MC and GN together designed the study and wrote the protocol. Author MCi conducted literature searches and provided summaries of previous research studies. Author GN conducted the statistical analysis. Authors MC and GN wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

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Gambling-Related Distortions and Problem Gambling in Adolescents: A Model to Explain Mechanisms and Develop Interventions

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Although a number of gambling preventive initiatives have been realized with adolescents, many of them have been developed in absence of a clear and explicitly described theoretical model. The present work was aimed to analyze the adequacy of a model to explain gambling behavior referring to *gambling-related cognitive distortions* (Study 1), and to verify the effectiveness of a preventive intervention developed on the basis of this model (Study 2). Following dual-process theories on cognitive functioning, in Study 1 we tested a model in which *mindware gap*, i.e., susceptibility to the gambler's fallacy, and *contaminated mindware*, i.e., superstitious thinking, were the antecedents of gambling-related cognitive distortions that, in turn, affect gambling frequency and problem gambling. Participants were 306 male adolescents (M_{age} = 17.2 years). A path analysis indicated that cognitive distortions have a mediating role in the relationship that links probabilistic reasoning fallacy and superstitious thinking with problem gambling. Following these findings, in Study 2 we developed a school-based intervention aimed to reduce gambling-related cognitive distortions acting on the above cited *mindware* problems. A pre- and post-test design – with a 6 months follow-up – was performed with 34 male adolescents (M_{age} = 16.8), randomly assigned to two groups (Training and No Training), and their baseline equivalence was verified. A Mixed 2 × 2 ANOVA attested a significant Time X Group interaction, indicating a significant reduction of the cognitive distortions from pre-test to post-test only in the Training group. The follow-up attested to the stability of the training effects and the reduction of gambling frequency over time. These findings suggest that prevention strategies should address *mindware* problems, which can be considered as predictors of gambling-related cognitive distortions.

Keywords: gambling, prevention, adolescents, gambling-related cognitive distortions, mindware, gambler's fallacy, superstitious thinking

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INTRODUCTION

Despite the restrictions to gamble for youth, prevalence studies report that a large number of adolescents are involved in gambling activities and that they are at higher risk for developing gambling problems compared to adults (see Blinn-Pike et al., 2010; Volberg et al., 2010, for reviews). There are alarming data as initiation of gambling at an early age is associated with a

higher risk of more severe gambling problems in adulthood (Johansson et al., 2009; Granero et al., 2014). Due to the potential negative consequences derived from gambling, prevention of problem gambling among adolescents has increasingly become an important area of concern in research and practice. For this reason, several educational initiatives have been realized (see Ladouceur et al., 2013; St-Pierre et al., 2015; Keen et al., 2016, for reviews). However, many of them have been developed in absence of an explicitly described theoretical model (Ladouceur et al., 2013; St-Pierre et al., 2015) and, even when a theoretical model has been proposed, it was adapted from other addictions' prevention approaches or it is often unclear how the theory was used in the program development (St-Pierre et al., 2015).

Following this premise, the goal of the present work was to fill this gap through two studies. In Study 1, we aimed to test a theoretically grounded model to explain gambling frequency and problem gambling referring to *gambling-related cognitive distortions,* i.e., a wide array of mistaken beliefs and perceptions about gambling (Raylu and Oei, 2004; Johansson et al., 2009). Then, in Study 2, we aimed to develop and verify the effectiveness of a preventive intervention focused on *gambling-related cognitive distortions* based on the model tested in Study 1.

STUDY 1

Referring to research with adults, dual-process theories on cognitive functioning have been used to explain cognitive failure that leads to persistent gambling behavior (Toplak et al., 2007). These theories distinguish between autonomous sets of systems (rapid, automatic, parallel, and heuristic) and analytic cognitive processes (slow, under control, serial, and rule-based) (see Stanovich, 2004, for a review). Toplak et al. (2007) used this model to explain how people tend to be irrational while gambling. Particularly, they considered problems regarding *mindware* (Perkins, 1995), defined as the rules, procedures, and strategies derived from past learning experiences and available for explicit retrieval. The authors stated that mindware problems can arise when there is a *mindware gap* or in the case of *contaminated mindware*. Specifically, there is a *mindware gap* when the appropriate rules, procedures, and strategies are lacking, while a *contaminated mindware* verifies when the employed mindware is not helpful in the specific situation. Referring to gambling, to operationalize the *mindware gap*, they referred to probabilistic reasoning ability in a variety of heuristic and bias problems and they proposed the disposition to believe in paranormal events, superstition, and luck to operationalize the *contaminated mindware*.

On one hand, a *mindware gap* in probabilistic reasoning, intended as the ability to draw conclusions about the likelihood of events based on available information or personal knowledge or beliefs, could have an important role in gambling. Indeed, it has been suggested that misunderstanding of probability can lead to irrational thoughts and behaviors related to gambling, such as chasing or obtaining false contingencies (Raylu and Oei, 2004). As reviewed by Goodie and Fortune (2013), misrepresentations about the chance of winning can derive from the representativeness heuristic, i.e., a tendency for people to base their judgment of the probability of a particular event on how much it represents the essential features of the parent population or of its generating process (Kahneman et al., 1982), and associated biases. For instance, one of the most documented biases related to gambling is *the gambler's fallacy*, which occurs when individuals believe that even short strings of random events must correspond with their perception of what constitutes randomness, leading to beliefs that particular outcomes are "due" (Tversky and Kahneman, 1971).

On the other hand, a *contaminated mindware* as superstitious thinking, i.e., the propensity of having beliefs based on perceiving biased casual relationships between unrelated events (Ninness and Ninness, 1998), can be related to distortions about gambling. Superstition, which appears during childhood and adolescence (Chiesi et al., 2010), is a thinking disposition that can affect reasoning regardless of cognitive abilities (Sá et al., 2005; West et al., 2008). Research and practice with adult pathological gamblers have shown that they have behavioral superstitions in which they associate certain habits with positive gambling results, cognitive superstitions in which they associate specific thought processes with winning, or talismanic superstitions in which they associate good luck charms with winning (Toneatto, 1999).

Taken together, *mindware gap* and *contaminated mindware*, as defined inside the above described dual-process framework, can provide an explanation for the mechanisms under which *gambling-related cognitive distortions* arise. These distortions, e.g., mistaken perceptions of the role of personal ability in gambling, misrepresentations of the chances of winning, false beliefs about the possibility to control or predict gambling outcomes, are deemed important risk factors for pathological gambling in both adults and adolescents. Indeed, high levels of cognitive distortions have been found to be associated with high levels of gambling frequency and to play an important role in the development of problem gambling in adults (Raylu and Oei, 2004; Arcan and Karanci, 2015; see Fortune and Goodie, 2012, for a review). Consistently, cognitive distortions related to gambling predict the frequency of gambling (Donati et al., 2015) and are strong predictors of problem gambling among adolescents (e.g., Taylor et al., 2014; Cosenza and Nigro, 2015; Donati et al., 2015).

Following these premises, we aimed to test a model in which susceptibility to the *gambler's fallacy* (*mindware gap*) and superstitious thinking (*contaminated mindware*) were associated with gambling frequency and problem gambling through gambling-related cognitive distortions. Indeed, given the importance of cognitive distortions in relation to gambling behavior, it becomes relevant to investigate their possible antecedents in young people. To the best of our knowledge, there are few studies on this topic and, in particular, there is a lack of studies attesting empirically the relationship between probabilistic reasoning and superstition to gambling-related cognitive distortions among adolescents.

We hypothesized that higher susceptibility to the gambler's fallacy and higher superstitious thinking would be related to higher gambling-related erroneous cognitions. Moreover, since both susceptibility to the gambler's fallacy and superstitious thinking have been found to be related to gambling behavior

among adolescents (e.g., Skoukaskas and Satkeviciute, 2007; Delfabbro et al., 2009; Chiu and Storm, 2010; Donati et al., 2013), we predicted that cognitive distortions related to gambling would mediate the relationship between susceptibility to the gambler's fallacy and superstitious thinking with gambling frequency and problem gambling. Furthermore, as the frequency of gambling has been found to be linked to the number of problem gambling symptoms (Chiu and Storm, 2010; Derevensky et al., 2010), we predicted that gambling-related cognitive distortions would affect problem gambling also indirectly through gambling frequency. Finally, as probabilistic reasoning biases have been found to be related to superstition (e.g., Kokis et al., 2002; Chiesi et al., 2010), we hypothesized a positive correlation between susceptibility to the gambler's fallacy and superstitious thinking.

Methods

Participants

Participants included 306 male adolescents (M_{age} = 17.2 years, SD = 1.5, range: 14–24) who attended high school in Italy (Tuscany). In line with some studies (e.g., Vitaro et al., 2004; Ricijas et al., 2016), we recruited only boys. Indeed, despite the expansion of the gambling industry has modified the male-dominated gambling culture (Dowling, 2013), gender differences in gambling behavior have been reported, indicating that boys are more likely than girls to gamble and to report gambling problems (see Splevins et al., 2010; Calado et al., 2016, for reviews). Written informed assent was provided by students and by the parents if the student was a minor.

Measures and Procedure

To measure susceptibility to the gambler's fallacy, the *Gambler's Fallacy Task* (GFT, Primi and Chiesi, 2011) was used. It consists of a marble bag game in which participants were asked which outcome was more likely at the next draw after a sequence of five equal outcomes (five blue or five green marbles). In more detail, the task was composed of three different trials in which the proportion of Blue and Green marbles in the bag varied (first trial: 15B and 15G; second trial: 10B and 20G; third trial: 25B and 5G). In total, each participant answered six questions. Summing fallacious answers, we computed a gambler's fallacy score ranging from 0 to 6, with higher scores corresponding to higher susceptibility to the gambler's fallacy.

To measure superstitious thinking, the *Superstitious Thinking Scale* (STS, Kokis et al., 2002; Italian version: Chiesi et al., 2010) was used. It is composed of eight Likert-type items using a 5-point scale ranging from *totally false* to *totally true*, yielding a maximum score of 40. Higher scores represent high levels of superstitious thinking. An example of an item is "*The number 13 is unlucky*". Coefficient alpha for the current sample was satisfactory ($\alpha = 0.77$).

The *Gambling Related Cognitions Scale* (GRCS; Raylu and Oei, 2004; Italian version: Iliceto et al., 2015) is a self-report scale to assess gambling-related cognitions. It contains twenty-three Likert-type items (using a 7-point scale ranging from *strongly disagree* to *strongly agree*) related to five biases regarding gambling measured by the following subscales: *Gambling Expectancies* (4 items; e.g., "*Having a gamble helps reduce tension and stress*"), *Illusion of Control* (4 items; e.g., "*Specific numbers and colors can help increase my chances of winning*"), *Predictive Control* (6 items; e.g., "*When I have a win once, I will definitely win again*"), *Inability to Stop Gambling* (5 items; e.g., "*It is difficult to stop gambling as I am so out of control*"), and *Interpretative Bias* (4 items; e.g., "*Relating my losses to bad luck and bad circumstances makes me continue gambling*"). The scale was previously found to have adequate validity and reliability among adolescents (e.g., Taylor et al., 2014; Donati et al., 2015). The coefficient alpha for the current sample was satisfactory ($\alpha = 0.89$). The GRCS subscale scores as well as the GRCS total score, obtained by summing the score for each item, were calculated. However, following the suggestion that only the total score for the GRCS should be used with adolescents (Taylor et al., 2014), the total score was used in the path model.

Gambling behavior was measured through the *South Oaks Gambling Screen-Revised for Adolescents* (SOGS-RA; Winters et al., 1993; Italian version: Colasante et al., 2014). This is one of the most widely instrument to measure problem gambling with adolescents (see Edgren et al., 2016, for a review), and its effectiveness has been attested by applying Item Response Theory (Chiesi et al., 2013). The scale is composed of two sections using the last year gambling behavior. In the first one, participants were asked to indicate the frequency of gambling (Never = 0, Less Than Monthly = 1, Monthly = 2, Weekly = 3, and Daily = 4) among a list of eleven gambling activities including: Playing cards for money, coin tosses for money, bets on games of personal skill, bets on sports teams, bets on horse or dog races, bingo, dice games for money, slot machines, scratch-cards, lotteries, and on-line games. Considering responses to this section, participants can be classified into *non-gamblers* (no gambling behavior) and *gamblers* (gambling on at least one activity) (Welte et al., 2009). Moreover, among gamblers, *non-regular gamblers* (i.e., those who participated from less than monthly to less than weekly in at least one gambling activity) and *regular gamblers* (i.e., those who participated weekly or daily in at least one gambling activity) can be identified (Winters et al., 1993). Finally, a total score of gambling frequency (range: 0–44) can be obtained by summing the responses for each gambling activity (Wickwire et al., 2007). The second section consists of 12 items related to the *Diagnostic and Statistical Manual of Mental Disorders* (III edition revised) criteria for pathological gambling (American Psychiatric Association, 1987). An example is: "*In the past 12 months, how often have you gone back another day to try to win back money that you lost?*". All items require dichotomous answers (i.e., yes or no) except the first item, which has a 4-point response scale (never, some of the time, most of the time, every time), and it is dichotomized (i.e., never/some of the time or most of the time/every time) in the scoring phase. A single composite score was computed summing the responses for each item of the second section. The total SOGS-RA score, indicative of the number of problem gambling symptoms, was used as dependent variable (range: 0–12), in line with previous studies (e.g., Wickwire et al., 2007, 2010). Finally, according to the narrow criterion (Winters et al., 1995), different categories of gamblers were identified: *Non-problem gamblers* (i.e., SOGS-RA scores from 0 to 1), *at-risk gamblers* (i.e., SOGS-RA scores

TABLE 1 | Descriptive statistics for gambler's fallacy, superstitious thinking, gambling-related cognitive distortions – the GRCS total score and the subscale scores – and problem gambling for non-regular gamblers ($n = 86$) and Regular gamblers ($n = 168$).

Dependent variable	Type of gamblers based upon gambling frequency		*t* (df)	*p*	Cohen's *d*
	Non-regular gamblers *M* (*SD*)	Regular gamblers *M* (*SD*)			
Gambler's fallacy	4.56 (*1.73*)	5.19 (*1.44*)	−2.74 (*252*)	<0.01	0.40
Superstitious thinking	18.49 (*6.25*)	21.36 (*7.10*)	−3.30 (*252*)	<0.01	0.43
Gambling related cognitive distortions – Total score	35.68 (*12.31*)	48.66 (*20.36*)	−6.32 (*252*)	<0.001	0.77
Gambling Expectancies	5.39 (*2.08*)	8.55 (*4.64*)	−7.49 (*252*)	<0.001	0.88
Illusion of Control	5.35 (*2.50*)	7.07 (*3.99*)	−4.20 (*252*)	<0.001	0.70
Predictive Control	11.65 (*5.67*)	14.42 (*6.36*)	−3.53 (*252*)	<0.001	0.46
Inability to Stop Gambling	6.54 (*2.68*)	8.46 (*2.57*)	−3.87 (*252*)	<0.001	0.73
Interpretative Bias	6.75 (*3.75*)	10.16 (*5.44*)	−5.86 (*252*)	<0.001	0.73
Problem gambling	0.60 (*1.06*)	1.81 (*2.07*)	−6.20 (*252*)	<0.001	0.74

from 2 to 3), and *problem gamblers* (i.e., SOGS-RA scores of 4 or more).

The above-described scales were administered in the classrooms and students were required to work individually. Teachers were not present during the administration of the scales, which required approximately 40 min.

Results

Results showed that 16% of the participants had never gambled. Then, we performed the analyses on adolescent gamblers, i.e., the 254 respondents who affirmed having gambled at least once during the last year. Among them, 66% were *non-regular gamblers* ($n = 86$), and 34% were *regular gamblers* ($n = 168$). The most common activities were scratch-cards (74%), sport bets (62%), and cards for money (47%), while the least engaged in activities were dice games for money (7%), bets on coin tosses (8%), and bets on horse or dog races (9%). Considering the score of the second section of the SOGS-RA, 75% ($n = 190$) of the respondents were *non-problem gamblers*, 19% ($n = 48$) *at-risk gamblers*, and 6% ($n = 16$) *problem gamblers*. Descriptive statistics of GFT, STS, GRCS, and the SOGS-RA based upon gambling frequency are displayed in **Table 1**, while descriptive statistics of the scales for the entire sample are reported in **Table 2**.

As reported in **Table 1**, results showed that *regular gamblers* were more susceptible to the gambler's fallacy, had higher levels of superstitious thinking and gambling related cognitive distortions, and reported more problem gambling symptoms than *non-regular gamblers*.

Then, we computed Pearson correlations to investigate the relationships among susceptibility to the gambler's fallacy, superstitious thinking, gambling-related cognitive distortions – the GRCS total score and the subscale scores-, gambling frequency, and problem gambling.

As shown in **Table 2**, gambling-related cognitive distortions were significantly and positively correlated both with susceptibility to the gambler's fallacy and superstitious thinking. In detail, with the exception of *Interpretative Bias*, all the five cognitive distortions were related to susceptibility to the gambler's fallacy and superstitious thinking, especially *Illusion of Control*, which shows, respectively, moderate and high correlations with the two variables. In addition, gambling-related cognitive distortions were significantly and positively correlated both with gambling frequency and problem gambling. Looking at GRCS subscales correlations, results indicated moderate and high correlations, with the highest between gambling frequency and *Gambling Expectancies*, while, *Inability to Stop Gambling* showed the highest Pearson coefficient value in the association with problem gambling. The results also showed that susceptibility to the gambler's fallacy was significantly and positively correlated with superstitious thinking, and both these variables were significantly and positively correlated with gambling frequency. The correlations between problem gambling were not significant. Finally, gambling frequency resulted to be significantly and positively correlated with problem gambling.

To investigate our hypothesis on the mechanisms underlying the relationships among these variables, we conducted a path analysis with AMOS using maximum likelihood estimation. The model included susceptibility to the gambler's fallacy and superstitious thinking as gambling-related cognitions' antecedents, and gambling-related cognitive distortions as antecedents of gambling frequency and problem gambling, which was directly affected by gambling frequency (**Figure 1**). Several goodness-of-fit indices were used to test the adequacy of the model: The Comparative Fit Index (CFI; Bentler, 1990), the Tuker-Lewis index (TLI; Tucker and Lewis, 1973), and the Root Mean Square Error of Approximation (RMSEA; Steiger and Lind, 1980). CFI and TLI values equal to.90 or greater (Tucker and Lewis, 1973; Bentler, 1990) and RMSEA values of.08 or below (Steiger and Lind, 1980) were considered as indices of adequate fit.

The hypothesized model showed a good fit to the data (CFI = 0.98, TLI = 0.94, RMSEA = 0.07). All coefficients were statistically significant and in the expected directions. Specifically, results revealed that susceptibility to the gambler's fallacy and superstitious thinking had significant direct positive effects on gambling-related cognitive distortions. Gambling-related cognitive distortions were directly and

TABLE 2 | Means, standard deviations, and correlations among gambler's fallacy, superstitious thinking, gambling-related cognitive distortions – the GRCS total score and the subscale scores -, gambling frequency, and problem gambling.

	1	2	3	4	5	6	7	8	9	10
1 Gambler's fallacy	–									
2 Superstitious thinking	0.21**	–								
3 Gambling-related cognitive distortions–total score	0.24***	0.28***	–							
4 *Gambling Expectancies*	0.20**	0.26***	0.82***	–						
5 *Illusion of Control*	0.25***	0.39***	0.72***	0.56***	–					
6 *Predictive Control*	0.20**	0.22***	0.83***	0.54***	0.55***	–				
7 *Inability to Stop Gambling*	0.19*	0.16*	0.72***	0.57***	0.38***	0.43***	–			
8 *Interpretative Bias*	0.10	0.12	0.79***	0.61***	0.42***	0.53***	0.49***	–		
9 Gambling frequency	0.15*	0.19**	0.50***	0.56***	0.30***	0.26***	0.49***	0.41***	–	
10 Problem gambling	0.11	0.03	0.54***	0.47***	0.25***	0.35***	0.53***	0.50***	0.54***	–
M (SD)	4.93 (*1.57*)	19.46 (*6.68*)	40.07 (*16.65*)	6.46 (*3.51*)	5.93 (*3.19*)	12.59 (*6.04*)	7.19 (*3.86*)	7.91 (*4.67*)	5.45 (*4.56*)	1.01 (*1.58*)

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

positively related to gambling frequency as well as problem gambling, and gambling frequency had a direct positive effect on problem gambling. Moreover, both susceptibility to the gambler's fallacy and superstitious thinking had significant indirect effects on gambling frequency, respectively 0.09 ($p < 0.01$) and 0.12 ($p < 0.01$), and on problem gambling, respectively 0.10 ($p < 0.01$) and 0.13 ($p < 0.01$). A significant indirect effect of 0.18 ($p < 0.01$) was also found between gambling-related cognitions and problem gambling Finally, a significant positive covariation was found between susceptibility to the gambler's fallacy and superstitious thinking.

Discussion

The aim of this study was to test the adequacy of a model explaining the relationship between susceptibility to the gambler's fallacy, superstitious thinking, gambling-related cognitive distortions, and gambling behavior among adolescents. In line with the predictions, findings revealed that the tendency to commit the gambler's fallacy and to be superstitious affects distorted cognitions about gambling. More specifically, higher susceptibility to commit the gambler's fallacy and higher superstitious thinking were related to greater levels of gambling-related cognitive distortions. Moreover, our model showed that cognitive distortions on gambling mediate the relationship between susceptibility to the gambler's fallacy and superstitious thinking with gambling behavior.

From a theoretical point of view, our findings confirm that there may be a cognitive-psychological mechanism through which faulty beliefs about gambling develop. In particular, results are consistent with Toplak et al.'s (2007) suggestions about the existence of two cognitive processes that affect problematic gambling behavior in adults–following a dual-process perspective on cognitive functioning (Stanovich, 2004)– i.e., difficulties in dealing with probability (*mindware gap*) and belief in superstition and luck (*contaminated mindware*).

Compared to previous research with adolescents, our study expands the current knowledge by suggesting that gambler's fallacy and superstitious thinking are related to gambling-related distortions in adolescence. Furthermore, this study suggests that the relationship between gambler's fallacy and problem gambling (e.g., Skoukaskas and Satkeviciute, 2007; Delfabbro et al., 2009; Donati et al., 2013), and the association of superstitious thinking with problem gambling (e.g., Chiu and Storm, 2010; Donati et al., 2013) can be explained by taking into account the mediating role of gambling-related cognitive distortions. In other words, adolescents more prone to mistaken perceptions of probability and with the tendency to adhere to superstitious beliefs are susceptible to cognitive distortions related to gambling. As such, they are particularly at risk since they have a greater likelihood of gambling with high frequency and developing gambling problems.

Although this model has been verified with a relatively small number of adolescent male gamblers, practical implications can be derived from the study. Indeed, our model can represent a theoretical based framework from which developing theory-driven interventions oriented to youth. Specifically, focusing on

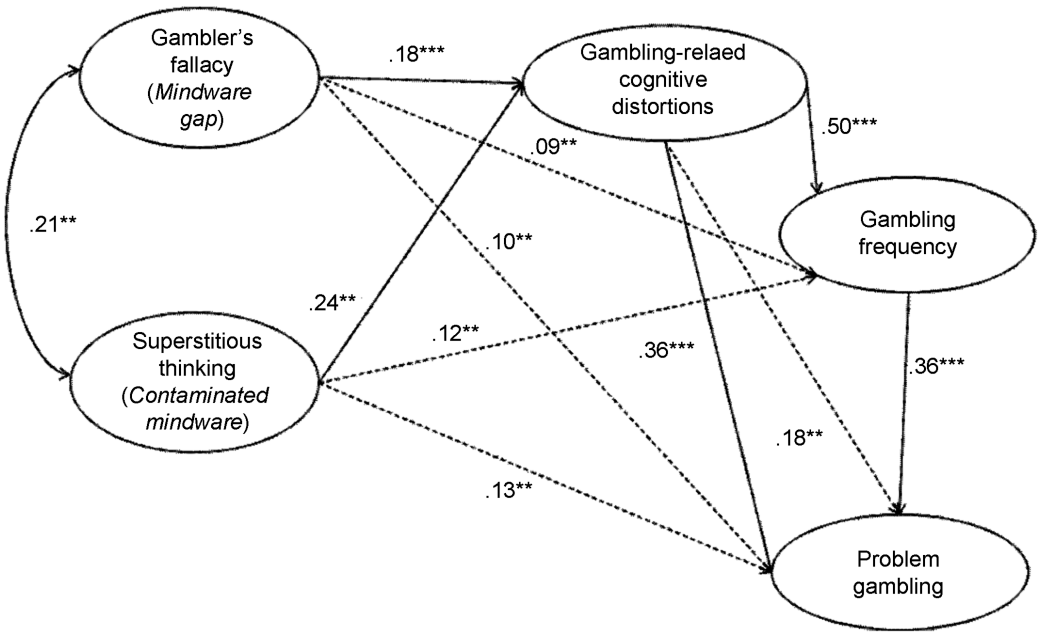

FIGURE 1 | Model of problem gambling with standardized parameters (significant path coefficient *** at the 0.001 level, ** at the 0.01 level). Dotted lines represent indirect effects, while continuous lines indicate direct effects.

these findings, a program aimed to modify gambling-related cognitive distortions can be developed. This was the aim of Study 2.

STUDY 2

Among the guidelines published by the Society for Prevention Research for the development of effective preventive interventions (Flay et al., 2005), there is the desirable standard that a clear theory of causal mechanism of the change promoted by the intervention should be stated. In particular, it would be important that the preventive program would be informed by theory and prior empirical analyses on antecedents and predictors of outcomes. Indeed, the systematic reviews conducted on the preventive interventions developed with adolescents in the school setting (Ladouceur et al., 2013; St-Pierre et al., 2015; Keen et al., 2016) agree in recognizing that many of the existing prevention programs have been developed in absence of a clear theoretical framework describing the expected causal mechanisms by which the programs would exert their effect.

Following this premise, once tested the adequacy of our model on gambling in Study 1, the goal of Study 2 was to develop and verify the effectiveness of a universal preventive intervention addressed to general samples of youth, regardless of risk or gambling status (Ladouceur et al., 2013; Keen et al., 2016) aimed to reduce gambling-related cognitive distortions by acting on probabilistic reasoning errors (*mindware gap*) and superstitious thinking (*contaminated mindware*). Additionally, moving from the theoretical guideline for which the main purpose of any prevention program should be to reduce the incidence of the potential problem (Ladouceur et al., 2013), we aimed to obtain behavioral changes related to gambling frequency, which is an antecedent of problem gambling (Chiu and Storm, 2010; Derevensky et al., 2010). Finally, due the "preventive" nature of the current intervention, reducing the incidence of problem gambling was outside our goals. In sum, following St-Pierre et al.'s (2015) classification framework, we developed a "*gambling-specific psychoeducational and skills training prevention program*" to reduce the erroneous cognitions on gambling acting on gambling-related knowledge, beliefs, attitudes, and skills as well as the awareness about the nature of gambling, knowing that all these factors may impact on adolescents' gambling habits.

In evaluating the effectiveness of the proposed intervention, we also wanted to take into account some relevant methodological issues. First of all, although a short-term change of gambling-erroneous cognitions have been obtained in several of these preventive initiatives (e.g., Ferland et al., 2002, 2005; Capitanucci et al., 2010; Williams et al., 2010; Donati et al., 2014; Huic et al., 2017), only few of them verified the stability of these effects over time (Gaboury and Ladouceur, 1993; Capitanucci et al., 2010; Donati et al., 2014). Thus, to provide evidence of the strength and stability of the change in the current intervention program, we assessed the short-term and long-term effects on gambling-related cognitions and also the long-term effects on gambling behavior. Secondly, we employed scales (i.e., SOGS-RA, GRCS, GFT, and STS) that were previously analyzed for their psychometric properties (see Study 1 for a detailed description). Indeed, the majority of the gambling intervention programs have not used psychometrically good measurement instruments to assess the variables of interest despite their obvious necessity (Ladouceur et al., 2013). Finally,

we employed an experimental design in which we verified the baseline equivalence of the experimental group and control group for the targeted variables of our intervention. Even in this case, with few exceptions (Williams et al., 2010; Donati et al., 2014), the baseline equivalence between the experimental and control groups has not been tested in past studies.

Methods

Participants

Participants were 34 male high school students (M_{age} = 16.80, SD = 1.04, range: 15–19) enrolled in a public high school in Tuscany (Italy). From the available schools in the area, one school was randomly selected. Subsequently, the school's principal was contacted, apprised of the issue of adolescent problem gambling to generate support for the research, and he was presented with the project. Once the school agreed to participate, the detailed study protocol was approved by the institutional review board of the school. Written informed consent was requested from students (or their parents, if they were minors), assuring them that the data would be handled confidentially. The research was conducted during school time and all students invited to participate agreed to do so. We chose a specific sample as it seems pertinent to deliver interventions to small groups of students that are homogenous in terms of risk factors, gambling habits, gender, and age (Ladouceur et al., 2013).

Measures

In line with Study 1, participants were administered the GFT, the STS, the GRCS, and the SOGS-RA (see Study 1 for description and scoring).

Procedure and Design

To evaluate changes in the dimensions considered in the study over time as a function of treatment condition, an experimental design was conducted with two groups (Training vs. No Training) and three measurements (pre-test, post-test, and follow-up sessions). Classes were randomly assigned to the Training and No Training conditions. The Training group consisted of 16 students (M_{age} = 16.99, SD = 1.20) and the No Training group consisted of 18 students (M_{age} = 16.63, SD = 0.89). For the Training group, participation involved filling out the above described scales before the intervention (pre-test), receiving training activities, filling out the GRCS after intervention (post-test), and then compiling the GRCS and the SOGS-RA six months (school break over the summer occurred during this interval) after the intervention has ended (follow-up). The pre-test, post-test, and follow-up questionnaires were administered also to the No Training group. Nevertheless, while the Training group received the intervention, the No Training group continued with usual school activity.

In the pre-test, post-test, and follow-up sessions, the scales were administered within the classrooms, and students were required to work individually. Teachers were not present during the administration of the scales. Administration of the instruments required approximately 40 min for the pre-test session, 15 min for the post-test session, and 25 min for the follow-up session. The Training group attended the intervention approximately 2 weeks after the pre-test, and the post-test was administrated 1 week after the end of the intervention and 5 weeks after pre-test data were collected. Few days after the follow-up session, a final meeting took place during which all the participants were given a feedback about the research and thanked for their participation.

The Intervention

Our intervention activities were based upon the model tested in Study 1. In detail, as cognitive distortions on gambling are affected by problems regarding *mindware gap*, i.e., probabilistic reasoning errors, and *contaminated mindware*, i.e., superstitious thinking, we wanted to implement activities in which adolescents could reinforce their ability to recognize biases in reasoning with randomness and could reflect about the irrationality of superstitions. Specifically, as for the *mindware gap*, activities focused on: Randomness with a series of coin tosses, independent random events employing a 40 cards desk, independence with equally likely and non-equally likely events represented with different colored paper sheets, gambler's fallacy in no-gambling and gambling contexts, and probabilistic reasoning in fictitious gambling situations. Regarding the *contaminated mindware*, participants were told about the superstition meaning and the lack of cause-effect relationship between a supposed event bringing bad or good luck and the supposed positive or negative event occurred referring to common superstitions. Then, referring more specifically to the relationship between superstition and gambling, several examples were presented about susceptibility to superstitious conditioning in gambling activities and the absence of a causal relationship between superstitious thoughts (e.g., the belief in lucky numbers) and gambling outcomes.

Concerning the training techniques, we integrated a mixed set of techniques including activities with random events generators, Power-Point presentations, and collective discussions. As for the methodology, each didactic unit included exercises in which students had to apply the learned ability/concept, and then they had to use the learned ability referring to fictitious gambling situations. In that way, training activities were aimed to promote the generalization of the proposed contents in real-life contexts. Concerning the procedure, each activity was implemented using a specific sequence: Initial instructions by the trainer, running the activity by the students, interactive discussion and synthesis of the contents, delivery of summary sheets to the students.

The intervention included two didactic units implemented in class, during the normal school time conducted by a developmental psychologist expert in the field of adolescent gambling research with a couple of operators belonging to the addiction unit of the socio-territorial service. Teachers were not present during the administration of the training program. Each didactic unit lasted about 2 h and were presented in a 2 week period (one per week).

Results

Results showed that 85% of the participants (n = 29) affirmed having gambled at least once during the last year.

Among them, 76% were *non-regular gamblers*, and 24% were *regular gamblers*. The most common activities were scratch-tickets (62%), sport bets (41%), and cards for money (23%). Considering the score of the second section of the SOGS-RA, 81% ($n = 23$) of the respondents were *non-problem gamblers*, 12% ($n = 4$) *at-risk gamblers*, and 6% ($n = 2$) *problem gamblers*.

Preliminarily, we tested the baseline equivalence of the Training and No Training groups for age and the targeted variables of our intervention. No significant differences were found between the two groups concerning age ($p = 0.316$), susceptibility to the gambler's fallacy ($p = 0.111$), and superstitious thinking ($p = 0.661$). Then, we analyzed the short-term efficacy of the intervention conducting a Mixed 2 × 2 ANOVA with Time (pre- and post-test) as within factor, Group (Training and No Training) as between factor, and gambling-related cognitive distortions as dependent variable.

A significant Time × Group interaction was found [$F(1,32) = 4.25$, $p < 0.05$, $\eta_p^2 = 0.117$]. *Post hoc t*-tests showed the interaction effects to be due to significant changes from pre-test to post-test in the Training group but not in the No Training group. Specifically, in the Training group there was a significant reduction of gambling-related cognitive distortions [$t(15) = 2.78$, $p < 0.05$, Cohen's $d = 0.69$) from pre-test ($M = 37.31$, $SD = 17.53$) to post-test ($M = 25.88$, $SD = 5.25$), while no significant changes occurred in the No Training group [$t(17) = -0.61$, $p = 0.552$] from pre-test ($M = 37.61$, $SD = 10.95$) to post-test ($M = 41.11$, $SD = 26.43$). Moreover, the two groups resulted to be significantly different for gambling-related cognitive distortions at the post-test [$t(32) = -2.26$, $p < 0.05$, Cohen's $d = 0.80$]. The Training group resulted to have lower levels of erroneous cognitions about gambling compared with the No Training group, while at the pre-test they have an equivalent level (**Figure 2**).

To verify the stability of the short-term effects over time, for the Training participants, we compared post-test and follow-up scores of gambling-related cognitive distortions. In detail, using paired *t*-tests, we compared post-test scores with the follow-up ones. Results showed no significant differences [$t(15) = -0.29$, $p = 0.780$] suggesting the permanence of the intervention effects over time for gambling-related cognitive distortions from post-test ($M = 25.88$, $SD = 5.25$) to follow-up ($M = 26.31$, $SD = 6.66$).

Subsequently, to verify whether the intervention had a decrementing effect on adolescent self-reported gambling behavior, a Mixed 2 × 2 ANOVA with Time (pre- and follow-up) as within factor, Group (Training and No Training) as between factor, and gambling frequency as dependent variable, was conducted. A non-significant Time × Group interaction was found [$F(1,32) = 1.70$, $p = 0.201$]. Nonetheless, since the sample size was small and important effect might be non-significant (i.e., Type II errors might be made), we looked at the effect size ($\eta_p^2 = 0.05$), which suggested that a small effect was obtained. As such, *post hoc t*-tests showed significant changes from pre- to follow-up in the Training group but not in the No Training group. Specifically, in the Training group there was a significant and medium size change of gambling frequency [$t(15) = 2.95$, $p < 0.05$, Cohen's $d = 0.73$], suggesting a reduction of gambling frequency from pre-test ($M = 3.69$, $SD = 4.96$) to follow-up ($M = 1.50$, $SD = 2.53$). On the contrary, no significant changes occurred in the No Training group [$t(17) = 0.04$, $p = 0.969$] from pre-test ($M = 3.94$, $SD = 4.45$) to follow-up ($M = 3.89$, $SD = 5.22$).

Discussion

Following the results of Study 1, the aim of the present study was to develop and evaluate a preventive intervention which would be able to modify erroneous cognitions about gambling by acting on probabilistic reasoning biases (*mindware gap*) and superstitious thinking (*contaminated mindware*). Findings showed that the intervention produced the hypothesized effects in the short-term as participants who attended the training program reduced their gambling-related cognitive distortions, while the participants who did not follow the training program

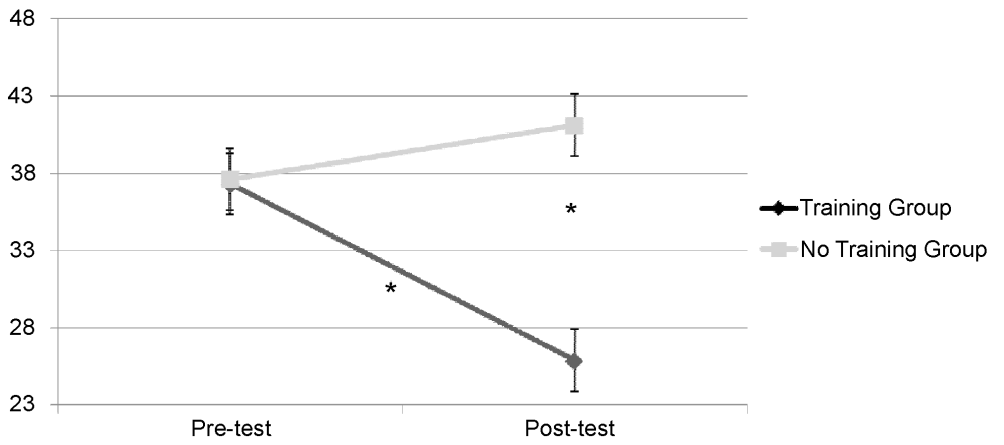

FIGURE 2 | Gambling-related cognitive distortions by Time (pre-test and post-test) and group (Training and No Training). *$p < 0.05$.

did not show a significant change from pre-test to post-test. This finding is of particular importance since research has generally provided evidence of a resistance to change for probabilistic reasoning biases (for a summary of the literature, see e.g., Gilovich et al., 2002; specifically, for adolescents, see Klaczynski, 2004). Additionally, the above described short-term results for gambling erroneous distortions were found to be stable after 6 months by the end of the intervention (i.e., the post-test mean scores did not differ significantly from the follow-up), indicating a substantial persistence of the effects over a period of six months for participants attending the training program.

Concerning the effects on gambling behavior, whereas some previous studies reported no behavioral changes despite improvements in knowledge and the reduction of cognitive errors (Gaboury and Ladouceur, 1993; Ferland et al., 2005; Turner et al., 2008; Huic et al., 2017), some changes were produced in gambling behavior. Specifically, in line with previous studies (Williams, 2002; Donati et al., 2014) we observed that only adolescents who attended the training program reduce their gambling frequency from pre-test to follow-up.

Finally, the methodological strengths of the current study, i.e., having tested short-and long-term effect of the intervention, having used effective instruments to measure the variables of interest, and having tested the baseline equivalence of the experimental and control group, attest to the worth and utility of the proposed intervention.

In sum, the current study provided evidence about the effectiveness of an intervention based upon an evidence-based theoretical model referring to the dual-process theoretical framework.

GENERAL DISCUSSION

The systematic reviews (Ladouceur et al., 2013; St-Pierre et al., 2015; Keen et al., 2016) conducted on the preventive interventions developed with adolescents in the school setting agree in recognizing that many of the existing prevention programs have been developed in absence of a clear theoretical framework describing the expected causal mechanisms by which the programs would exert their effect. Overcoming the limitations of the previous studies, this work proposed and tested the effectiveness of a gambling preventive intervention with adolescents after having previously verified the adequacy of a theoretical model explaining adolescent gambling involvement. With respect to the application of dual-process theories on cognitive functioning in the prediction of gambling behavior (Toplak et al., 2007), our model proposed that susceptibility to the gambler's fallacy and superstitious thinking (respectively, *mindware gap* and *contaminated mindware*, according to the dual-process theory) were the predictor variables of gambling-related distorted cognitions in adolescence, while gambling frequency and problem gambling were the outcome variables. This study supports the results suggested by Clark (2010) that the high propensity for individuals commit mistakes in reasoning and judgment makes them particularly vulnerable to adhere and maintain cognitive distortions related to gambling. With specific reference to the practical implications of the model, our results provided a theoretically grounded model useful not only to explain gambling-related cognitions but also to develop interventions to modify them.

More broadly speaking, this work showed that dual-process theory of cognition (see Evans and Stanovich, 2013; for a review) can be used as conceptual framework to explain and prevent gambling behavior in adolescence. There have been only few attempts to apply it to adolescents, with few exceptions (see Klaczynski, 2004, for the employment of this theory to explain adolescent social and cognitive development), and little research has been conducted in order to investigate its application in the field of adolescent health behavior. Nevertheless, it has been suggested the utility of dual-process theories in explaining and predicting many types of health behaviors in adolescence as they involve both analytic and heuristics processing (Gibbons et al., 2009). Thus, the present studies provided some empirical support about the applicability of dual-process theories to explain and modify gambling-related erroneous cognition and gambling behavior, in some extent. More in detail, the intervention we developed following the dual-process model resulted was effective in reducing gambling-related erroneous cognitions in the short-term and in producing a stable change of these cognitions in the long-term. Additionally, there was a transfer of learning about gambling-related cognitions onto gambling behavior resulting in a reduction of gambling frequency after six months by the end of the intervention. Nonetheless, the medium effect size of this difference confirms the existing difficulties in changing gambling behavior among adolescents through educational interventions (Keen et al., 2016).

Concerning this point, the effectiveness of this intervention in reducing an important risk factor for maladaptive gambling behavior (i.e., gambling-erroneous cognitions) is very important as it has been showed that preventive programs that obtain change in risk and protective factors are more successful than programs showing behavior change (Foxcroft and Tsertsvadze, 2012). Moreover, these kind of programs focused on changing specific correlates of maladaptive gambling behavior may have effects that extend to other health behaviors (Hawkins et al., 2015).

Whereas this work has a number of strengths, including the evaluation of a theoretical model then linked to a gambling preventive intervention, and the use of good psychometric instruments, there are some limitations to take into account. First, as our work was conducted with boys attending Italian public high school, caution has to be paid about the generalizability of the present results. Future studies should be conducted in order to test the adequacy of the theoretical model with broader samples of adolescents, for instance including also girls. Moreover, although the descriptive data about gambling behavior were in line with previous data with adolescent males (e.g., Gupta et al., 2004; Olason et al., 2006), the small number of participants in Study 2 limits the impact of the current

results concerning the developed preventive intervention. Future studies should be conducted with wider samples in order to evaluate the effectiveness of the intervention based on gambling behavior and severity. Finally, as research indicates that various and different factors increase the likelihood of problem gambling in adolescents (e.g., Donati et al., 2013; Cosenza and Nigro, 2015), it should be important to investigate theoretical models taking into account other variables in addition to susceptibility to the gambler's fallacy and superstitious thinking as predictors of gambling-erroneous cognitions.

ETHICS STATEMENT

This study was carried out in accordance with the APA recommendations of psychology deontology with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the ethical committees of each school.

AUTHOR CONTRIBUTIONS

MD developed the theoretical model and constructed the intervention, which she conducted in the school setting. FC collaborated in the data analysis and revised the preliminary versions of the paper. AI promoted the research project among the schools and contacted the school headmasters. AM and FF participated in data interpretation. CP supervised the entire research project and gave her contribution in the theoretical and practical discussion of the results.

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Comparative Analysis of Potential Risk Factors for at-Risk Gambling, Problem Gambling and Gambling Disorder among Current Gamblers—Results of the Austrian Representative Survey 2015

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Background: The risk of developing a problem gambling behavior is distributed unequally among the population. For example, individuals who report stressful life events, show impairments of mental health or belong to a socio-economically deprived group are affected more frequently by gambling problems. The aim of our study is to investigate whether these risk factors are equally relevant for all gambling groups (social = 0 DSM-5 criteria, at risk = 1 DSM-5 criterion, problem = 2–3 DSM-5 criteria, disordered = 4–9 DSM-5 criteria).

Methods: Of a total of 10,000 participants in the representative gambling survey in Austria in 2015, 4,082 individuals reported gambling during the last 12 months and were allocated to the four gambling groups according to DSM-5. With social gamblers as the reference group, relevant risk factors for the other three groups were identified by means of bi- and multivariate multinomial logistic regression.

Results: Significant risk factors for gambling disorder are at-risk alcohol use (OR = 4.9), poor mental health (OR = 5.9), young age (≤26 years, OR = 2.1), a low level of formal education (OR = 2.4), having grown up with a single parent (OR = 2.5), parents with addiction problems (OR = 2.3) and belonging to the working class (OR = 2.9). Risk factors for problem gambling are parents with addiction problems (OR = 3.8), poor mental health (OR = 2.6) and a young age (OR = 2.2). With regard to at-risk gambling, only growing up with a single parent was relevant (OR = 2.4).

Conclusion: Overall, the results of this study suggest, that the number and the influence of the included risk factors differ between gambling problem groups. Apparently, the development of severe gambling problems is to a lesser extent facilitated by specific risk

factors than by their cumulative presence. Therefore, future prevention and treatment measures should place a particular focus on individuals who have experienced growing up in a difficult family situation, have poor mental health, suffer from substance-related problems or have a low level of formal education.

Keywords: gambling, gambling disorder, risk factors, logistic regression, Austria

INTRODUCTION

In addition to genetic variables as a relevant factor for the development of problem gambling (Potenza et al., 2005; Black et al., 2014; Lobo et al., 2015), acceptance and availability of gambling, the cultural background of the person participating in gambling, the social and sociodemographic characteristics, as well as personality traits and mental health play an important role in the development of pathological gambling (Clarke, 2005).

With the exception of lotteries, gambling is a leisure activity performed more often by men than by women. Notably, men prefer types of gambling which are considered to be of particularly high risk for the development of problem gambling behavior, such as slot machines, casino games or sports betting (Hing et al., 2016). Therefore, it is not surprising that, compared to women, men are at a higher risk for developing gambling problems (Abbott et al., 2013; Barnes et al., 2015; Subramaniam et al., 2015). Age is another important demographic risk factor. Particularly younger age groups are disproportionately affected (Subramaniam et al., 2015; Abbott et al., 2016; Hing et al., 2016). Furthermore, individuals with a migration background develop a problem gambling behavior more frequently than persons who do not have such a background (Volberg et al., 2001; Buth, 2011; Hing et al., 2016).

Moreover, a low level of formal education (Fröberg et al., 2015; Subramaniam et al., 2015) and a social status below average (Volberg et al., 2001; Barnes et al., 2015) represent further relevant potential risk factors for problem gambling.

In addition to their gambling problems, many pathological gamblers are also affected by depressive or anxiety disorders (Barry et al., 2011; Bischof et al., 2013; Billi et al., 2014; Martin et al., 2014; Shultz et al., 2016). In a meta-analysis, Dowling et al. (2015) showed that an average of 75.5% of the pathological gamblers (currently in treatment) examined in the included studies, were affected by at least one additional comorbid mental disorder (axis I). More than half had been diagnosed with depression and about one quarter had an anxiety disorder. These mental health problems can be a cause as well as a consequence of problem gambling (Hodgins et al., 2005). However, regardless of causality issues, comorbid mental disorders indicate a higher risk of being affected by gambling problems.

Aside from the reported mental health impairments and certain personality traits, substance-related disorders are of great importance (Kessler et al., 2008; Barry et al., 2011; Bischof et al., 2013; Martin et al., 2014; Subramaniam et al., 2015; Shultz et al., 2016). In their meta-analysis Lorains et al. (2011) reported that 28.1% of pathological gamblers had an alcohol use disorder. With regard to illegal substances, the respective share was 17.2%. Similar to other addictive disorders, children of parents with a problem gambling behavior are at increased risk of developing gambling problems (Williams et al., 2015; Dowling et al., 2016). A number of studies on substance-related problems showed that having grown up with a single parent increased the risk of developing this sort of problem behavior (Blum et al., 2000; Latendresse et al., 2017). However, with regard to problem gambling, the effects of being raised by a single parent have been analyzed in only few studies. Ste-Marie (2005) found that the share of persons who grew up with single parents increased with the extent of the gambling problems. The studies by Canale et al. (2017) and Cheung (2014) also showed that persons who had not been raised by both parents had a higher risk of developing gambling problems.

The addictive potential of gambling varies with the different gambling products. While, in comparison, the use of lotteries and scratch cards leads to gambling problems rather rarely, sports betters, individuals who prefer casino games and especially persons who use slot machines are at higher risk of developing a gambling disorder (Scalese et al., 2016). This is particularly the case if the participation in these gambling forms occurs on a regular basis (Williams et al., 2015; Binde et al., 2017).

The above mentioned findings show that problem gambling is associated with a multitude of variables from various areas. Even though they do not always precede the development of gambling problems, these characteristics indicate a higher risk among affected individuals for also having a gambling problem. The results of the reported studies are predominantly outcomes of bivariate analyses, partly controlled by demographic variables. However, using these procedures, it cannot be excluded that the associations found are in fact the results of spurious relationships. The number and the importance of relevant factors of influence therefore might be overestimated. If however risk factors are simultaneously included in a multivariate analysis, the correlations between the variables included in the analysis are subtracted (controlled) and the effectively relevant factors can be determined.

Furthermore, the above mentioned studies are based on different definitions of problem gambling. While many studies only include individuals in the affected group who meet the criteria for pathological gambling (e.g., DSM-IV $\geq$ 5 criteria), other studies also include persons with problem (e.g., 3-4 DSM-IV criteria) or at-risk gambling behavior (1-2 DSM-IV-criteria). Although the latter procedure is understandable from a methodological perspective, as, particularly in representative surveys, the number of pathological gamblers is often too small for statistical analysis, it is nevertheless questionable when it comes to content. Thus, Shen et al. (2015) showed that moderate-risk gamblers (Problem Gambling Severity Index (PGSI): 3–7) differ significantly from problem gamblers

(PGSI: ≥8) regarding psychological distress and possible alcohol dependence. Furthermore, the latter group participates significantly more frequently in poker games and sports betting and also takes part in online gambling considerably more often. However, given that both groups differ with regard to these characteristics, one may assume that factors which facilitate gambling problems are of varying importance within these groups.

Aim of the present study is to identify potential risk factors for disordered, problem, and at-risk gambling and to assess their respective relevance. If the analysis shows that the influence of variables varies with the severity of the gambling problem, existing treatment, protection and prevention measures would have to be adapted or new interventions would need to be developed from scratch for each of the individual problem groups.

METHODS

Sample

The analysis is based on data of a general population survey on gambling behavior in Austria in 2015. The survey included sociodemographic and biographic data as well as data on gambling behavior, motives for gambling, alcohol use, mental health problems, suicidal thoughts and behavior as well as attitudes toward prevention measures (Kalke et al., 2016).

The basic population of the study consists of 14 to 65 year old inhabitants living in private households in Austria. This basic population is reduced to a sampling frame of German speaking individuals.

Data collection was conducted by means of computer assisted telephone interviews (CATI). The telephone numbers were drawn from public telephone directories (mobile and landline) using random sampling. The sample was stratified according to the number of inhabitants of each of the Austrian federal states.

Prior to the interview, the contacted individuals were asked to report the name of the federal state of their residence, their age and their gender. Only if the contacted person met the criteria of a yet not fully recruited quota, the full interview was carried out. In multiple-person households, the person with the next birthday coming up was interviewed (next-birthday-method). The interviews were conducted between January 9, 2015 and June 22, 2015.

A sample of 32,830 telephone numbers was drawn using the method described above. 11,890 numbers of this sample were neutral non-responses (invalid number, person not reached, no person in the target group e.g., regarding age, no private household, no communication possible). A total of 20,701 individuals had to be contacted in order to reach the targeted number of 10,000 interviews which equals a response rate of 48.3%. 18 cases were excluded from further analysis due to missing answers to DSM questions. Furthermore, only those 4,082 individuals who had reported gambling during the last 12 months were included in the following analyses.

Missing values were also found for other variables included in the analysis: professional status ($n = 7$); migration background ($n = 18$); parents with addiction problems ($n = 37$); growing up with a single parent ($n = 10$); alcohol problems (total score: $n = 76$); mental health problems (total score: $n = 230$). These missings were imputed with multiple imputation algorithms included in the statistical software MPlus 7.31 (Muthén and Muthén, 2015).

Despite the use of complex sampling procedures, achieving full representativeness of the sample is generally not possible. Therefore, the distributions in samples of representative surveys always differ slightly from those in the basic population. These differences are corrected post hoc by using weighting factors. The calculation of these weighting factors is based on the variables "federal state," "age," "gender," and "formal education." The weights were determined according to the distribution of these parameters among the Austrian general population.

This article is based on a secondary analysis of anonymized data from phone interviews for which all respondents gave oral consent before beginning the interview. They were free to withdraw at any time and without giving any reason. The data cannot be linked to the respondents. As the consultation of an ethics committee is not mandatory in the case of anonymized data collection and analysis, we refrained from requesting an ethics vote.

Potential Risk Factors Included in the Analysis

The variables that should undergo testing were selected primarily on the basis of findings of other international studies which have investigated this issue (see above). As representative surveys are quite costly and respondents are only willing to participate in phone interviews for a limited amount of time, only items which could be validly assessed by means of very brief instruments such as Alcohol Use Disorder Identification Test-Consumption Questions (AUDIT-C) and the Mental Health Interview (MHI-5) were included. Apart from these two instruments, other risk factors included in the analysis were gender, age, highest qualification reached in school, migration background, addiction problems of parents, growing up with a single parent, professional status and participation in high risk gambling forms (sports betting, slot machines in and outside of casinos and casino games [i.e., roulette, poker]) on at least a monthly basis.

Measures

Assessment of Gambling Problems

Gambling problems were operationalized using the criteria of the German language version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (Falkai et al., 2015). The DSM-5 provides nine criteria, which describe the main characteristics of a gambling disorder. These criteria were assessed using an instrument developed by Stinchfield (2002) for the DSM-IV which was adapted to DSM-5 by removing the criterion of having committed illegal acts to finance gambling. Stinchfield (2003) appraised the original instrument to be of satisfactory reliability, validity, and classification accuracy. The instrument adapted to DSM-5 includes 18 questions which can be answered with no (0) or yes (1). With the exception of criterion 4 (withdrawal symptoms), all criteria are operationalized through

two individual questions. One criterion is met if at least one of the questions is answered with yes. If respondents meet four or more criteria, they are allocated to the group of gambling disorder. Respondents who meet two or three criteria are allocated to the group of problem gamblers. The group of at-risk gamblers meets only one of nine possible criteria.

As it can be assumed that individuals who only gamble occasionally or only spend small amounts of money on gambling do not develop gambling-related problems, the DSM-5 screening was conducted only for respondents who gambled at least once a week or spent at least 50 € per month.

Assessment of Alcohol Use

The 10-item AUDIT is a screening questionnaire developed by the WHO to identify harmful or hazardous alcohol consumption (Saunders et al., 1993).The AUDIT-C, consisting of the first three questions of the AUDIT (quantity, frequency and binge drinking) was developed as an even briefer, easy to administer screening measure. Both AUDIT and AUDIT-C are recommended by various guidelines. In this study, the AUDIT-C was used to assess alcohol use (Bush et al., 1998). The values of the predefined answers range from 0 to 4 points, with 12 points being the maximum total. The cut-off value in German speaking countries has been found to be 5 for men and women (Mann et al., 2016).

Assessment of Mental Health

The Mental Health Inventory-5 (MHI-5) was used as a screening instrument for mental health (Berwick et al., 1991). For Germany, the MHI-5 was validated by Rumpf et al. (2001) and was shown to be of satisfactory psychometric quality with regard to affective disorders and anxiety disorders.

The MHI-5 consists of five questions referring to nervousness, depressiveness with no possibility of solace, downheartedness and sadness, calmness, and happiness within the last 4 weeks. The five answer options range from "always" (1) to "never" (5). For the items calmness and happiness polarity needs to be reversed (recoding). Raw scores of 18 or less indicate problems in the area of mental health (Rumpf et al., 2001).

Analysis

Common testing procedures were applied to test differences between the different gambling problem groups. These include the χ^2-test (for dichotomous and categorical variables) as well as variance analysis procedures (for variables with a metrical measurement scale). In case of inhomogeneous variances of analyzed items, significance tests were conducted using the Welch-Test (Zimmerman, 2004).

The relevance of the included risk factors for the three problem groups (disorder, problem, at-risk) in comparison to the reference group (social gamblers) was initially tested by means of bivariate multinomial logistic regression analyses. For this procedure all four groups are included simultaneously in the analysis, but only one independent variable is included at a time (i.e., no controlling for third variables).

Bivariate analyses may allow for a first appraisal of the relevance of the included factors. However, this method cannot be used to assess whether the detected effects were possibly influenced by correlations with other potential risk factors. Therefore, in a second step, multivariate multinomial logistic regressions were conducted by simultaneously including all those potential risk factors in the analysis which were considered relevant and provided a sufficient number of cases for each problem gambling group. By doing so, correlations between different factors can be subtracted out (controlled).

In order to assess the strength of the association between the included factors, tetrachoric correlations were calculated on the basis of dichotomized items. The only exception was the DSM-5 which was included in the correlation analysis as a 4-step-scale (1 = "no criteria met," 2 = "1 criterion met," 3 = "2–3 criteria met," and 4 = "4–9 criteria met") (polychoric correlation).

Data preparation and calculation of χ^2-tests, variance analyses and Welch-tests were performed with the use of the statistics program SPSS, version 15. The statistics software MPlus (Muthén and Muthén, 2015), version 7.31, was applied in order to perform the bivariate and multionomial regressions and to calculate the tetrachoric and polychoric correlations.

RESULTS

Of all respondents 40.9% (N = 4,082) reported to have participated in some kind of gambling within the last 12 months. The 12-month prevalence for a gambling disorder (DSM-5 $\geq$ 4 criteria) is 0.8% (N = 81). The number of respondents meeting 2 to 3 DSM-5 criteria is N = 72 (0.7%) and 121 (1.2%) meet one DSM-5 criterion (at-risk gambling). 3,808 respondents (38.8%) have participated in gambling within the last 12 months prior to the interview, but do not show any indications for gambling problems (social gambling).

In order to describe these four groups, a comparison was made regarding a range of variables which are considered as traditional risk factors for problem gambling (see introduction). The analysis shows that with growing severity of the gambling problems, the share of male gamblers increases (see **Table 1**). However, a significantly higher risk for males to be part of a problem group can only be found for disordered gamblers. Furthermore, individuals aged up to 26 bear a higher risk for disordered or problem gambling. Individuals with a migration background, a low level of formal education and the professional status of being a working class member are represented disproportionately strongly within the group of disordered gamblers. The corresponding odds ratios are only statistically relevant for this group.

The situation is different regarding the experience of growing up with a single parent. Although this constellation is most frequent among disordered gamblers, this item also constitutes a relevant risk factor among problem and at-risk gamblers.

More than 4 out of 10 disordered and problem gamblers further report to have parents with gambling- or substance-related problems of their own. For this group, the risk of being a disordered or problem gambler is increased by factor 5. In the group of at-risk gamblers however, the odds ratios do not differ significantly.

TABLE 1 | Potential risk factors for at-risk, problem, and disordered gambling – Results of the univariate logistic Regression.

		Disordered (*N* = 81)		Problem (*N* = 72)		At-risk (*N* = 121)		Social (*N* = 3,808)	F/χ^2	*p*-value
		Mean/%	OR [95%-CI]+	Mean/%	OR [95%-CI] +	Mean/%	OR [95%-CI] +	Mean/%		
Female gender [ref.]		21.0	3.2 [1.7–6.1]	32.4%	1.8 [1.0–3.4]	34.9%	1.6 [1.1–2.4]	46.3%	$\chi^2 = 31.6$	$p < 0.001$
Age [ref. ≥27]	14–17	12.4%	3.6 [1.9–7.1]	8.5%	2.7 [1.3–5.6]	2.6%	1.0 [0.5–2.0]	1.3%	$\chi^2 = 111.1$	$p < 0.001$
	18–26	30.0%		26.8%		14.2%		15.4%		
	27–35	18.5%		27.8%		22.9%		18.6%		
	36–50	20.8%		19.2%		32.6%		34.5%		
	≥51	18.3%		17.7%		27.6%		30.1%		
	Mean (SD)	33.5 (13.2)		33.4 (12.5)		40.4 (12.5)		41.9 (13.3)	$F = 19.8$	$p < 0.001$
School-leaving qualification [ref: Intermediate secondary school or higher]	General secondary school	50.7%	4.9 [2.6–9.1]	27.5%	1.8 [0.9–3.8]	19.0%	1.1 [0.6–2.0]	17.4%	$\chi^2 = 70.4$	$p < 0.001$
	Intermediate secondary school	40.4%		53.4%		47.0%		51.8%		
	higher education entrance qualification/university degree	8.8%		19.1%		34.0%		30.8%		
Migration background [ref: no migration]		36.2%	3.4 [1.7–6.4]	17.1%	1.2 [0.6–2.4]	19.5%	1.4 [0.8–2.3]	14.7%	$\chi^2 = 28.2$	$p < 0.001$
At-risk alcohol use [ref: AUDIT-C ≤ 4]		63.8%	9.0 [4.8–16.9]	37.5%	3.1 [1.6–6.0]	28.1%	1.9 [1.2–3.1]	16.7%	$\chi^2 = 136.5$	$p < 0.001$
	Mean (SD)	5.3 (3.3)		3.7 (3.0)		3.1 (2.9)		2.6 (2.0)	F=20.2	$p < 0.001$
Mental health problems [ref: MHI-5 ≥ 19]		71.0%	8.0 [3.6–17.6]	47.5%	3.1 [1.6–6.2]	24.4%	1.1 [0.7–1.8]	23.1%	χ^2 =102.2	$p < 0.001$
	Mean (SD)	15.9 (3.7)		18.8 (3.2)		20.0 (3.0)		20.1 (2.9)	$F = 33.5$	$p < 0.001$
Having grown up with a single parent [ref: with both parents]		43.0%	4.5 [2.4–8.4]	27.2%	2.2 [1.1–4.3]	30.0%	2.5 [1.6–4.0]	14.5%	χ^2 =76.7	$p < 0.001$
Parents with gambling- or substance-related problems [ref: parents without such problems]		46.0%	5.3 [2.8–9.8]	43.0%	4.6 [2.5–8.7]	17.7%	1.3 [0.8–2.2]	14.0%	χ^2 =106.0	$p < 0.001$

(Continued)

TABLE 1 | Continued

		Disordered (*N* = 81)		Problem (*N* = 72)		At-risk (*N* = 121)		Social (*N* = 3,808)	F/χ^2	*p*-value
		Mean/%	OR [95%-CI]+	Mean/%	OR [95%-CI] +	Mean/%	OR [95%-CI] +	Mean/%		
Professional status [ref. not working class]	Working class	43.6%	5.9 [3.1–11.1]	14.7%	1.3 [0.5–3.3]	17.0%	1.6 [0.8–2.9]	11.6%	$\chi^2 = 106.6$	$p < 0.001$
	Salaried employee/civil servant	11.1%		29.2%		34.2%		43.1%		
	Freelancer	14.9%		26.1%		18.8%		12.1%		
	Not employed	30.4%		30.0%		30.1%		33.2%		
Gambling forms (gambling at least monthly) [ref: respective participation less than monthly]	Sports Betting	60.4%	36.7 [19.2–70.1]	35.8%	13.4 [6.9–26.1]	22.6%	7.0 [4.2–11.8]	4%	$\chi^2 = 605.9$	$p < 0.001$
	Casino Games	11.8%	12.4 [4.5–34.0]	22.7%	27.1 [12.2–60.1]	15.5%	16.9 [8.1–35.3]	1.1%	$\chi^2 = 305.1$	$p < 0.001$
	Slot-Machines (Casino)	2.5%	14.1 [2.0–100.5]	3.3%	18.6 [2.9–119.8]	3.5%	19.7 [2.4–158.9]	0.2%	$\chi^2 = 53.5$	$p < 0.001$
	Slot-Machines (arcade halls, Bars, Restaurants)	31.0%	64.5 [26.2–158.8]	5.6%	8.6 [2.4–30.9]	5.6%	8.6 [2.9–25.4]	0.7%	$\chi^2 = 506.7$	$p < 0.001$

+ = Reference category for the dependent variable for bivariate multinomial logistic regression: social gamblers; SD, standard deviation; OR, odds ratio; CI, confidence interval.

Almost two thirds of disordered gamblers show at least at-risk use of alcohol. With 37.5%, this share is considerably smaller among problem gamblers, but the percentage is still 20 points higher than among social gamblers. Also at-risk gamblers are disproportionately strongly affected by alcohol-related problems. Therefore, an at least at-risk use of alcohol is a relevant risk factor for all three problem groups.

A similar distribution was found regarding mental health. 71.0% of the disordered gamblers and almost half of the problem gamblers show psychological distress. However, among at-risk and social gamblers, this share amounts to less than a quarter. With odds ratios of 8.0 for disordered gambling and 3.1 for problem gambling, this item proves to be one the most relevant risk factors for gambling-related problems.

Table 1 further shows that at least monthly participation in sports betting, casino games and slot machines significantly increases the risk of being part of one of the three gambling problem groups. Within the group of disordered gamblers this is particularly true for sports betting and slot machines in gambling halls, bars and restaurants. On the other hand, only very few respondents reported such an intense gambling behavior. Therefore, the number of cases included in the analysis is small and correspondingly the confidence intervals of the OR are very wide. Thus, the logistical regression cannot provide reliable information on the importance of different gambling forms for the particular gambling problem groups. For this reason, the different forms of gambling are not included in the following multivariate analysis.

Multivariate analyses allow for controlling the effects of third variables. For this reason, a multivariate multinomial logistic regression was calculated for the factors presented in **Table 2**. The results show that at-risk alcohol use (OR = 4.0) and impaired mental health (OR = 5.9) are still particularly relevant risk factors for disordered gamblers. However, through controlling the influence of all other variables, the respective odds ratios turn out lower than in the bivariate analyses. This is also true for all other significant factors such as young age (OR = 2.1), low formal education (OR = 2.4), growing up with a single parent (OR = 2.5), having parents with addiction problems of their own (OR = 2.3), as well as being a working class member (OR = 2.9), whereas the factors of migration background and gender are no longer of statistically significant influence. Notably less statistically significant risk factors can be found for the group of problem gamblers. These are young age (OR = 2.2), impaired mental health (OR = 2.6), and having parents with gambling or substance-related problems (OR = 3.8). Remarkably, at-risk alcohol use is no longer of (statistical) relevance for the group of problem gamblers.

With regard to at-risk gambling, having grown up with a single parent remains the only statistically significant risk factor. Among persons who report this, the risk of meeting exactly one DSM-5 criterion is increased by a factor of 2.4 compared to individuals who have grown up with both parents.

The results of the multivariate logistic regression are largely consistent with those of the bivariate analyses. Here, migration background and particularly gender constitute an exception as these two variables are no longer significant in the multivariate model. It is reasonable to assume that disproportionately high correlations with other included variables exist. In fact, the factor migration background correlates considerably with several of the included variables (see **Table 3**). This is the case for age of less than 27 years, having grown up with a single parent and low formal education. Even higher correlations could be found regarding gender. Here strong correlations exist with risky alcohol use ($r = 0.55$) and the professional status of being a working class member ($r = 0.45$). Another high correlation was identified with regard to age ($r = 0.23$). Furthermore, at-risk alcohol use correlates disproportionately highly with age ($r = 0.30$) and professional status ($r = 0.34$).

DISCUSSION

The study at hand is the first internationally to assess risk factors for gambling-related problems as a function of problem severity according to DSM-5. With regard to disordered gamblers, the analysis showed that impaired mental health is an import risk factor. This finding is consistent with the results of various other studies (Kessler et al., 2008; Barry et al., 2011; Bischof et al., 2013; Martin et al., 2014; Subramaniam et al., 2015; Shultz et al., 2016). The same applies to at-risk alcohol use (Lorains et al., 2011; el-Guebaly et al., 2015; Williams et al., 2015). The level of correlation with the DSM-5 problem status is indeed above average for both impaired mental health and at-risk alcohol use, while inter-correlation between both variables is rather low ($r = 0.13$). Due to the cross-sectional design of the study, two different interpretations are possible here. One interpretation is that mental health problems and at-risk alcohol use are two different ways to react to gambling problems and their consequences. On the other hand, disordered gambling could be interpreted as a consequence of psychological and substance-related problems. In this case, both factors would constitute classical risk factors. However, due to the absence of a longitudinal design, this issue cannot be solved with the existing data. Nevertheless, individuals with impaired mental health and at-risk alcohol use constitute an important risk group for disordered gambling on which future prevention and therapy measures should place a greater focus.

For the remaining statistically relevant items, the direction of the correlation is not an issue. Either they cannot be influenced by gambling behavior (e.g., gender or age) or the development of these characteristics precedes the emergence of gambling problems. This is the case for young age (≤26 years old), low formal education, the professional status of being a working class member, having parents who have addiction problems or having grown up with a single parent. While the former have been confirmed as relevant factors by a multitude of studies, the influence of growing up with a single parent has yet hardly been analyzed. A significant odds ratio of 2.5 indicates that this group is particularly vulnerable for developing a disordered gambling behavior. A possible explanation is provided by Black et al. (2012). Here, worse family functioning in comparison to non-disordered gamblers was found to be an important risk factor for disordered gambling. As single parents are on their own regarding the organization of family life, it is fair to assume that

TABLE 2 | Potential risk factors for disordered, problem, and at-risk gambling–Results of the multivariate multinomial logistic regression.

Risk factors	Disordered (*N* = 81)			Problem (*N* =72)			At-risk (*N* = 121)		
	OR+	95%-CI	*p*	OR+	95%-CI	*p*	OR+	95%-CI	*p*
Male gender [ref. Female gender]	1.8	[0.9–3.8]	0.111	1.6	[0.8–3.3]	0.180	1.4	[0.9–2.1]	0.104
Age ≤ 26 years old [ref. ≥27]	2.1	[1.1–4.2]	0.036	2.2	[1.0–4.9]	0.045	0.8	[0.4–1.6]	0.512
Low formal education [ref: Intermediate secondary school or higher]	2.4	[1.2–5.0]	0.014	1.3	[0.6–2.8]	0.479	1.0	[0.6–1.8]	0.975
Migration background [ref: no migration]	1.8	[0.9–3.6]	0.123	0.9	[0.4–2.0]	0.768	1.3	[0.8–2.2]	0.355
At-risk alcohol use	4.0	[2.0–8.2]	0.000	1.9	[0.9–4.0]	0.101	1.6	[1.0–2.6]	0.052
Mental health problems [ref: MHI-5 ≥ 19]	5.9	[2.7–13.1]	0.000	2.6	[1.3–5.3]	0.006	1.1	[0.7–1.7]	0.836
Having grown up with a single parent [ref: with both parents]	2.5	[1.2–5.0]	0.011	1.5	[0.7–3.2]	0.337	2.4	[1.6–3.8]	0.000
Parents with addiction problems of their own [ref: parents without such problems]	2.3	[1.1–4.5]	0.019	3.8	[1.9–7.6]	0.000	1.1	[0.7–1.9]	0.596
working class [ref. no working class member]	2.9	[1.4–6.1]	0.003	0.8	[0.3–2.3]	0.718	1.3	[0.7–2.4]	0.482

+ = Reference category for the dependent variables for multivariate multinomial logistic regression: social gamblers (0 DSM-IV-criteria; N = 3,808) OR, odds ratio; CI, confidence interval.

TABLE 3 | Tetrachoric and polychoric correlations of relevant potential risk factors.

	DSM-5	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
(I): Male gender	0.21***								
(II): Age ≤ 26 years old	0.22***	0.23***							
(III): Low formal education	0.24***	0.03	0.17***						
(IV): Migration background	0.18***	0.07*	0.15***	0.16***					
(V): At-risk alcohol use	0.38***	0.55***	0.30***	0.07*	0.07				
(VI) Mental health problems	0.32***	−0.11***	0.01	0.16***	0.09**	0.13***			
(VII): Having grown up with a single parent	0.31***	0.02	0.20***	0.19***	0.17***	0.10**	0.12***		
(VIII): Parents with addiction problems	0.33***	−0.09**	−0.03	0.15***	0.12***	0.13***	0.22***	0.26***	
working class	0.27***	0.45***	0.08*	0.14***	0.04	0.34***	0.07*	0.06	0.14***

*Tetrachoric and polychoric correlations based on dichotomized risk factors; DSM-5, ordinal (4 categories) Significance: ***p < 0.001; **p < 0.01; *p < 0.05.*

problems accumulate in such cases. Furthermore, the precarious financial situation which single parents are often confronted with, is also associated with worse family functioning (Mansfield et al., 2013). Children who grow up with single parents also more often have at least one parent who is affected by gambling- or substance-related problems ($r = 0.26$). Therefore, the risk of transgenerational transmission of addiction is increased within this group (Vassoler et al., 2014).

It seems somewhat surprising that within the multivariate model, gender should not make a statistically significant difference between disordered gamblers and social gamblers. However, a close look at the correlations suggests that the alleged gender effect may rather be an effect of the social milieu. For at-risk use of alcohol, young age, and the status "working class" are associated closely. As such a milieu is dominated by males these variables also highly correlate with gender. If the reciprocal effects of these variables are controlled in a multivariate model, the influence of the gender variable is reduced considerably. This allows for the conclusion that the affiliation with a milieu of adolescent workers and drinkers significantly increases the risk for disordered gambling. Here, the gender of those affiliated with the milieu is not the decisive factor. Sharpe (2002) has identified the association between the drinker's milieu and gambling problems. She argues that slot machines are available in many bars and pubs where drinkers meet and that they are therefore frequently in contact with this highly addictive form of gambling.

Far fewer risk factors were identified for the group of problem gamblers. Among these are young age, mental health impairments, as well as parents with gambling- and substance-related problems. The disproportionately high correlation between the two latter variables ($r = 0.22$) can be interpreted as an indication that growing up with parents who have addiction problems of their own leads to mental health problems which are in turn suppressed by gambling (maladaptive coping). In many respects, this behavior would correspond to the development which Blaszczynski and Nower (2002) describe for the subgroup of emotionally vulnerable problem gamblers in their pathways model. If this is the case, problem gambling can be understood as a precursor for disordered gambling. In order to prevent this development in the future, there would be a need for prevention measures which convey the knowledge and skills to respond to existing mental health problems in another way.

At-risk gambling behavior cannot be predicted by means of traditional risk factors. Solely the factor of having grown up

with a single parent was found to be statistically significant in the multivariate model. As this variable was also relevant for disordered gambling, special attention should be paid to children and youths growing up in such family constellations. The reasons why individuals who have undergone this kind of socialization develop a risk or disordered gambling behavior need to be investigated in further studies. Apart from the above mentioned dysfunctional family structures and parents' addiction problems, further important characteristics could be a lack of monitoring by parents, low problem-solving skills, low self-esteem and the company of other youths who are at risk of developing gambling problems themselves.

Bastiani et al. (2013) also tested the relevance of different risk factors for gambling problem groups (CPGI-classification: no risk, low-risk, moderate-risk or problem gambling) by means of a multivariate multinomial logistic regression. While gender and age were relevant for both problem groups, low to medium formal education and tobacco use we only relevant for moderate-risk or problem gamblers.

Furthermore, (Bischof et al., 2013) analyzed the importance of substance-related as well as anxiety and mood disorders for the affiliation with gambling problem groups, but could not find any differences between these groups. However, the study was based on a slightly different allocation of problem groups (DSM-IV, pathological: 5–10 criteria, problem: 3–4 criteria, risk: 1–2 criteria) and only clinically manifest disorders were included in the analysis, whereas the study at hand used brief screening instruments which also identify more moderate forms of these disorders.

Due to the small number of cases within the problem groups, the different gambling forms were not included in the multivariate analyses. Nevertheless, the univariate analyses confirm the relevance of a regular participation in sports betting, casino games and slot machines for the emergence of gambling-related problems (Williams et al., 2015; Binde et al., 2017). It is notable in this regard that the share of individuals who gamble in casinos is disproportionally high in the at-risk and problem gambling groups. Whereas many gamblers who use slot machines in gambling halls, bars and restaurants can be found in the group of disordered gamblers. The shares of sports betters are large in all gambling problem groups. However, in this context one needs to take into account that in Austria sports betting is performed more frequently on a regular basis than casino games or gambling at slot machines. As a whole, the results show that future prevention measures should focus particularly on these three and similar high-risk gambling forms.

Furthermore, it is a recognized fact that gamblers switch between different gambling problem groups throughout their gambling careers. Therefore, the gambling problem groups identified in this article only reflect the situation at the time of the interview.

LIMITATIONS

Some limitations should be considered regarding the above mentioned results. Younger respondents, individuals from educationally deprived strata, and interviewees with a migration background were underrepresented in the given sample. Weighting was an attempt to ensure representativeness—at least with respect to the two first mentioned variables. Furthermore, interviews were only conducted with individuals who felt capable of being interviewed by phone and in German language. However, these limitations apply to almost all studies focusing on the general population—regardless of their particular topics. Moreover, the study at hand may slightly underestimate the number of individuals which meet the DSM-5 criteria, as it only included respondents who either play at least once a week or spend at least 50 € per month on gambling in the screening.

Finally, this is a cross-sectional study. This entails that, in strictly methodological terms, the relationships between at-risk/problem/disordered gambling and the other variables included in the analysis are only correlations. The assumptions which have been made particularly in the discussion section of this article are based on content-related considerations which would need to be tested in a longitudinal study.

CONCLUSION

The results of this study suggest that the amount and the influence of statistically relevant risk factors differ among the three analyzed gambling problem groups. The differences between the respective gambling problem groups can hardly be explained with substantially different influence factors. Instead, the accumulation of existing risk factors seems to facilitate the development of gambling problems. Therefore, future prevention and treatment measures should focus especially on individuals who have grown up in difficult family situations, whose mental health is impaired, and who show substance-related disorders. Particularly this should be the case if they come from educationally deprived families. Apparently, adolescents with mental health or alcohol problems are at a particular risk of additionally developing gambling problems. This needs to be considered by facilities which provide counseling and treatment for the former problems, in order to prevent an additional development of gambling problems.

AUTHOR CONTRIBUTIONS

JK, NT, FW, and SB: designed the study together and organized the data collection; SB: was responsible for the analyses and the draft of the manuscript; NT, FW, and JK: participated in the interpretation of the data and results; HL and FW: critically revised the manuscript for important intellectual content and approved the final version to be published.

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Risk Factors for Gambling Problems on Online Electronic Gaming Machines, Race Betting and Sports Betting

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Growth of Internet gambling has fuelled concerns about its contribution to gambling problems. However, most online gamblers also gamble on land-based forms, which may be the source of problems for some. Studies therefore need to identify the problematic mode of gambling (online or offline) to identify those with an online gambling problem. Identifying most problematic form of online gambling (e.g., EGMs, race betting, sports betting) would also enable a more accurate examination of gambling problems attributable to a specific online gambling form. This study pursued this approach, aiming to: (1) determine demographic, behavioral and psychological risk factors for gambling problems on online EGMs, online sports betting and online race betting; (2) compare the characteristics of problematic online gamblers on each of these online forms. An online survey of 4,594 Australian gamblers measured gambling behavior, most problematic mode and form of gambling, gambling attitudes, psychological distress, substance use, help-seeking, demographics and problem gambling status. Problem/moderate risk gamblers nominating an online mode of gambling as their most problematic, and identifying EGMs ($n = 98$), race betting ($n = 291$) or sports betting ($n = 181$) as their most problematic gambling form, were compared to non-problem/low risk gamblers who had gambled online on these forms in the previous 12 months ($n = 64$, 1145 and 1213 respectively), using bivariate analyses and then logistic regressions. Problem/moderate risk gamblers on each of these online forms were then compared. Risk factors for online EGM gambling were: more frequent play on online EGMs, substance use when gambling, and higher psychological distress. Risk factors for online sports betting were being male, younger, lower income, born outside of Australia, speaking a language other than English, more frequent sports betting, higher psychological distress, and more negative attitudes toward gambling. Risk factors for online race betting comprised being male, younger, speaking a language other than English, more frequent race betting, engaging in more gambling forms, self-reporting as semi-professional/professional gambler, illicit drug use whilst gambling, and more negative attitude toward gambling. These findings can inform improved interventions tailored to the specific characteristics of high risk gamblers on each of these online activities.

Keywords: gambling, problem gambling, risk factors, internet gambling, online gambling, gambling disorder, interventions

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INTRODUCTION

Participation in online gambling continues to increase in tandem with its deregulation, prolific advertising, the widespread uptake of computer and mobile technologies, and increased availability of high speed internet access (Wood and Williams, 2011; Gainsbury, 2012; Hing et al., 2014a). These developments have fuelled concerns that online gambling contributes substantially to gambling problems, prompting research into online problem gamblers, including their characteristics, prevalence, and associated risk factors (Wood and Williams, 2007, 2009; Wardle et al., 2011; Gainsbury et al., 2013; Hing et al., 2014b). While these studies have provided insights into the characteristics and behaviors of problem gamblers who gamble online, they have typically not accounted for an important issue that can confound such analyses. This is that not all problem gamblers who engage in online gambling have a gambling problem related to their online gambling. In fact, most online gamblers also gamble on land-based forms (Wardle et al., 2011; Gainsbury et al., 2015a) which may be the main source of problems for some. Thus, to automatically attribute gambling problems amongst online gamblers to their use of online modes of gambling is inaccurate and overestimates the impact of Internet technologies on problem gambling.

A second issue potentially confounding an accurate understanding of problem online gambling is that measures of problem gambling, such as the PGSI (Ferris and Wynne, 2001), DSM (American Psychiatric Association, 2000, 2013) and the South Oaks Gambling Screen (Lesieur and Blume, 1987), do not distinguish the gambling form(s) causing problems. Both of these issues may lead to erroneous conclusions. For example, based on the above assumptions, an individual with a gambling problem related to land-based electronic gaming machines (EGMs) and who occasionally purchases an online lottery ticket (and is therefore classified as an online gambler) may be wrongly assumed to have problems with online lottery gambling. Both online gambling and lottery gambling would be incorrectly implicated in this example, based on the usual categorisation of problem online gamblers and the inability of traditional measures of problem gambling to distinguish the gambling form causing problems.

Studies need to identify the problematic mode of gambling (online or offline) and problematic form of gambling (e.g., EGMs, race betting, sports betting) to be able to more accurately characterize those with a gambling problem attributable to a specific online gambling form. This study pursues this approach and aims to: (1) determine demographic, behavioral and psychological risk factors for gambling problems on online EGMs, online sports betting and online race betting; and (2) compare the characteristics of problematic online gamblers on each of these online forms. Understanding risk factors is important to inform improved targeting of harm minimisation and other public health measures for Internet gambling. Further, identifying risk factors for each online gambling form will enable additional tailoring of these measures to high-risk consumers who engage in each of these activities. Literature on the characteristics of online gamblers and online problem gamblers, along with associated risk factors, is now briefly reviewed to contextualize this study.

Characteristics of Online Gamblers

Several studies have compared online gamblers to offline gamblers (Griffiths et al., 2009, 2011; Wood and Williams, 2009; Gainsbury et al., 2012, 2015b). These analyses have classified online gamblers as those who have gambled at least once in the past year using an Internet mode of gambling, with the remaining gamblers classified as offline gamblers. These analyses therefore distinguish non-Internet gamblers from individuals who have gambled online. This latter group may include online-only gamblers, those who gamble mainly online and those who gamble mainly offline, including one-time-only online gamblers. Thus, individuals classified as online gamblers can vary widely in their proportionate engagement with online modes of gambling. Despite this heterogeneity, a reasonably consistent profile of online gamblers has emerged. Compared to offline gamblers, online gamblers are more likely to be male, younger, more highly educated, have higher incomes, engage in a greater number of gambling activities, and have higher problem gambling rates. (Griffiths et al., 2009; Wood and Williams, 2009; Svensson and Romild, 2011; Gainsbury et al., 2015b). More fine-grained analyses categorizing online gamblers into online-only, offline-only and mixed-mode gamblers have generally found these characteristics to be more pronounced amongst mixed-mode gamblers (Wardle et al., 2011; Gainsbury et al., 2015a).

Characteristics of Problem Online Gamblers and Associated Risk Factors

Research has also compared problem online gamblers to non-problem online gamblers to determine risk factors for gambling problems amongst Internet gamblers. Compared to non-problem online gamblers, problem online gamblers tend to be male, younger, to gamble on a wider range of activities, to have higher gambling expenditure, to hold more erroneous gambling beliefs, and to hold more negative attitudes toward gambling (Wood and Williams, 2007, 2009; Gainsbury et al., 2015c). Other studies have compared online problem gamblers to offline problem gamblers, in attempting to isolate distinctive risk factors associated with online modes of gambling. Amongst problem and moderate risk gamblers, Gainsbury et al. (2013) found that those who gambled online were more likely to be younger, engage in more types of gambling activities, and to bet on sports. In a clinical sample of problem gamblers, those who gambled online were found to have higher educational levels, socio-economic status, gambling expenditure and gambling debts, with no differences in clinical, psychopathological and personality characteristics, compared to offline problem gamblers (Jiménez-Murcia et al., 2011).

While the above two types of comparisons are legitimate and informative, confusion arises when results are interpreted as meaning that online gambling is necessarily the source of gambling problems amongst those categorized as problem online

gamblers. Indeed, the relatively high problem gambling rates found amongst online gamblers (Petry and Weinstock, 2007; Wood and Williams, 2007, 2011; Griffiths et al., 2009; Hing et al., 2014a) have often been inferred as meaning that online gambling is riskier than land-based gambling. However, as noted above, offline modes may be the source of gambling problems for a proportion of this group. Indeed, Wood and Williams (2007) found that a preference for non-Internet gambling was one predictor of problematic gambling amongst a sample of 1,920 Internet gamblers. They therefore speculated that online gambling may not necessarily facilitate problem gambling, but that problem gamblers may instead be drawn to online gambling, or more generally, multiple modes of product delivery. This emphasizes the need to distinguish most problematic gambling mode amongst online problem gamblers in order to correctly assess the role of Internet modes of access in problem gambling.

To our knowledge, only one study has analyzed the characteristics of problem gamblers whose gambling problems relate specifically to online gambling (Hing et al., 2015b). Amongst a convenience sample of 620 problem gamblers, 46% nominated an Internet gambling mode as their most problematic; with access being made either via computers, mobile phones, tablets, or interactive television. These problem online gamblers were significantly more likely than problem offline gamblers to be male, younger, have lower psychological distress, experience problems with sports and race betting, spend more time and money on these gambling forms, have lower problem gambling severity and lower rates of help-seeking. While that study more accurately categorized problem online and offline gamblers and provided useful insights into how they differ, it did not examine factors that increase the risk of transitioning from a non-problem online gambler to a problem online gambler. It also did not examine risk factors for different forms of online gambling, as this current study will do.

In summary, most studies of online problem gamblers have not determined whether their gambling problem is specifically related to an Internet mode of gambling. These analyses therefore include online gamblers with offline gambling problems. This lack of distinction of most problematic gambling mode amongst dual-mode gamblers means that risk factors for online gambling remain uncertain. Further, these studies have not distinguished which form of online gambling is most problematic. They have therefore been unable to identify risk factors for specific forms of online gambling. This study seeks to overcome these issues by conducting analyses comparing those who attribute their problems to each of three forms of online gambling (EGMs, sports betting, race betting) to those who also gamble online on those forms and have not experienced problems, and then comparing the groups who attribute their problems to these three online forms to each other. These analyses are the first to specifically study the characteristics and risk factors of gamblers whose problems develop in each of these online gambling forms. Because of the early stage of this avenue of research, the current research is considered exploratory and no specific hypotheses are presented Similar to previous analyses of risk factors for different types and modes of gambling (e.g., Wood and Williams, 2009; Gainsbury et al., 2015c; Hing et al., 2016e), a range of demographic, behavioral and psychological factors are included, as identified below. The findings can inform improved interventions tailored to the specific characteristics of high-risk gamblers on each of these online gambling activities.

MATERIALS AND METHODS

Participants and Recruitment

A total of 4,594 eligible respondents completed an online survey which targeted Australian adults who had gambled in the past 12 months. Participants were recruited via advertisements on Internet gambling sites ($n = 2{,}475$) and on gambling-related sites ($n = 535$), such as help services. Participants were also recruited through advertisements on Facebook ($n = 810$) and via Google AdWords ($n = 288$). These recruitment methods were employed to specifically oversample online gamblers. The overall sample was mostly male (77.8%) with a mean age of 42.1 years ($SD = 14.7$).

Inclusion Criteria

Inclusion criteria were: (a) non-problem or low-risk gamblers based on the Problem Gambling Severity Index (PGSI; Ferris and Wynne, 2001) who reported gambling online on EGMs, sports betting or race betting, or (b) moderate-risk or problem gamblers (also based on the PGSI) who specifically attributed their gambling problem to online gambling on EGMs, sports betting or race betting. The latter criterion was determined by two survey questions. The first question asked respondents which gambling mode of access had contributed most to any problems they may have experienced from their gambling. As we were specifically interested in problems related to online gambling, we excluded anyone who stated that their problems were due to land-based or telephone gambling. The second question asked about the most problematic form of gambling. Ten forms were surveyed (such as instant scratchies, bingo, keno, lotteries). The three most commonly selected forms amongst those who stated that their problems were due to online gambling were: online race betting ($n = 291$), online sports betting ($n = 181$) and online EGM gambling ($n = 98$). All other forms were selected by too few respondents to be included in the following analyses. As the respondents could only select one form (race betting, sports betting or EGM gambling), the MR/PG groups are mutually exclusive.

Measures

Problem Gambling

All respondents completed the 9-item PGSI (Ferris and Wynne, 2001), which is the most widely used and recommended measure of problem gambling severity in Australia (Problem Gambling Research and Treatment Centre, 2011). Response options were "never" (0), "sometimes" (1), "most of the time" (2) and "almost always" (3). Based on their total score, respondents were then

categorized into non-problem gambler (0), low risk gambler (1–2), moderate risk gambler (3–7) and problem gambler (8–27). Cronbach's alpha for the PGSI in this sample was 0.93.

Demographics

Respondents completed questions related to their: gender (male/female), age (in years), education (recoded into those with or without a tertiary degree), income, work status (recoded into those working and not working, such as those on a pension, retired, unemployed), country of birth (Australia or other), and main language spoken at home (English or other).

Gambling Behavior

Respondents completed questions related to: frequency of engagement on each of ten forms of gambling over the last 12 months (which was also used to calculate a variable that determines how many of the different forms they engage in), the percentage of engagement in each form that was done online, self-reported gambler status (professional, semi-professional, amateur), alcohol use when gambling (no vs. at least sometimes), and illicit drug use when gambling (no vs. at least sometimes). Those who stated that they had gambling-related problems were also asked whether they thought they needed help in relation to their gambling (no or yes) and whether they had ever sought any of 10 types of help in relation to their gambling (recoded into no help-seeking vs. yes to any combination of the 10 types of help).

Psychological Variables

Respondents completed the Kessler 6 (K6; Kessler et al., 2002). For each of the K6 items covering symptoms of nervousness, hopelessness, restlessness, depression, worthlessness, and effort, the response options were: 'none of the time' (0), 'a little of the time' (1), 'some of the time' (2), 'most of the time' (3) and 'all of the time' (4). A sum of the scores on all six items was calculated to give an index of psychological distress. Despite the widespread use of the K6, no clear optimal scoring standards are available (Kessler et al., 2010). The most commonly used thresholds based on validation studies were therefore used: scores of 0–12 indicating no distress, 13+ indicating mild to high levels of distress, and raw scores were also analyzed. Respondents were also asked about their attitudes toward gambling, on a scale from "the harms far outweigh the benefits" to "the benefits far outweigh the harms," with lower scores indicating a more negative attitude toward gambling.

Data Analysis

We conducted two major sets of analyses. First we compared the moderate-risk/problem gamblers whose problems reportedly stemmed from each online form (EGMs, sports betting, race betting) to non-problem/low-risk gamblers who engaged in that form online. Hereafter, we refer to the former group as problematic online gamblers and the latter group as non-problematic online gamblers.

The second set of analyses compared three groups of respondents: those whose problems reportedly stemmed from online EGMs, online race betting and online sports betting. All gamblers in these groups were moderate risk or problem gamblers and had nominated that online gambling on that form was responsible for their gambling-related problems.

Both sets of analyses followed the same structure: the relevant groups were compared on demographic, gambling behavior and psychological variables using bivariate, pairwise analyses. These were conducted using chi-square tests of independence (with pairwise tests of proportions where required) for categorical variables, or with one-way ANOVA (with Tukey pairwise comparisons where required) for continuous variables. For gambling frequency and percentage of gambling done online, Mann–Whitney *U*-tests were conducted. Effect sizes are reported for statistically significant results.

Given that discriminatory power can be shared between two or more independent variables, binary logistic regressions predicting problem gambling status were also conducted, to determine which of the significant variables from the bivariate analyses remained significant when controlling for the other variables. An alpha of 0.05 was used throughout.

In terms of missing data, the income question included an option to not disclose this information. This variable was considered in the bivariate analyses, but not the logistic regressions. We did also perform regressions including income, noting that it made very little difference to the results. Therefore, we have opted to report the results with income excluded. The K6 was also excluded from the regression results, as it was highly correlated (>0.6) with the PGSI (which was included as a predictor in the first comparisons, and was the factor that differentiated the groups in the latter comparisons). Tolerance checks were also conducted on the regression models and tolerance was >0.4 for all variables in all models, once K6 was excluded.

We also explored other possible analyses, including multinomial logistic regression models, where all predictors included in the binomial logistic regression models reported in **Tables 8–10** were included, in order to explore potential concerns around Type I error and predictor choice. The results were very similar to those from the binomial logistic regression models. We have opted to retain the binomial results because we see the comparisons between the groups as separate analyses that require separate predictors, and have thus modeled each comparison separately.

Ethics Statement

This study was carried out in accordance with the recommendations of the National Statement on the Ethical Conduct of Research Involving Humans, and was reviewed and approved by Southern Cross University Human Research Ethics Committee. All subjects gave written informed consent in accordance with the Declaration of Helsinki. Because of the sensitive nature of the survey and the vulnerability of the sample, an informed consent preamble warned that some questions may have been confronting and challenging for some respondents, assured respondents of confidentiality and anonymity, and

advised that respondents could withdraw their participation at any time. The survey contained contact details for telephone and online gambling help services.

RESULTS

Comparisons between Non-problematic Online EGM Gamblers and Problematic Online EGM Gamblers

Bivariate Analyses

Compared to non-problematic online EGM gamblers, problematic online EGM gamblers had significantly lower incomes. They gambled on EGMs more frequently, and were significantly more likely to use alcohol or illicit drugs at least some of the time when gambling. They were significantly more likely be experiencing psychological distress, and to have significantly more negative attitudes toward gambling (**Table 1**).

Multivariate Analyses

All of the significant variables from the bivariate analyses were included in a multivariate logistic regression, with the exception of income and Kessler 6. Lowest tolerance between the variables was 0.85, indicating no multicollinearity problems. The overall model was significant $\chi^2(5, N = 162) = 36.68$, $p < 0.001$ and correctly classified 70.5% of cases overall.

The results were similar to the bivariate analyses, with the exception that the gambling attitudes variable was no longer significant when controlling for the other variables in the model (**Table 2**).

Comparisons between Non-problematic Online Sport Gamblers and Problematic Online Sports Bettors

Bivariate Analyses

Compared to non-problematic online sports bettors, problematic online sports bettors were significantly more likely to be male, younger, have a lower income, be born outside of Australia, and speak a language other than English as their main language at home. They gambled on sports more frequently, but did less of their sports betting online, and were significantly more likely to consider themselves to be semi-professional gamblers. They were significantly more likely to use illicit drugs at least some of the time when gambling, to be experiencing psychological distress, and to have more negative attitudes toward gambling (**Table 3**).

Multivariate Analyses

All of the significant variables from the bivariate analyses were included in a multivariate logistic regression. Lowest tolerance between the variables was 0.89, indicating no multicollinearity problems. The overall model was significant $\chi^2(10, N = 1394) = 243.25$, $p < 0.001$ and correctly predicted 73.0% of cases overall.

The results were relatively similar to the bivariate analyses, although percentage of sports betting conducted online, self-reported professional gambling status and drug use when gambling were no longer significant (**Table 4**). Problematic online sports bettors were significantly more likely to be male, younger, born in a country other than Australia, speak a language other than English at home, gamble on sports more frequently and have a more negative attitude toward gambling.

Comparisons between Non-problematic Online Race Bettors and Problematic Online Race Bettors

Bivariate Analyses

Compared to non-problematic online race bettors, problematic online race bettors were significantly more likely to be male, younger, less likely to have a degree, and more likely to have a lower income, be born in Australia, and to speak a language other than English at home. They gambled on races more frequently, did less of their race betting online, and were significantly more likely to gamble on more forms of gambling. They were significantly more likely to rate themselves as a semi-professional gambler, and to use drugs at least sometimes when gambling. They were significantly more likely be experiencing psychological distress, and to have more negative attitudes toward gambling (**Table 5**).

Multivariate Analyses

All of the significant variables from the bivariate analyses were included in a multivariate logistic regression. Lowest tolerance between the variables was 0.83, indicating no multicollinearity problems. The overall model was significant $\chi^2(12, N = 1434) = 275.49$, $p < 0.001$ and correctly predicted 75.3% of cases overall.

The results were relatively similar to the bivariate analyses, although education, country of birth and percentage of race betting conducted online were no longer significant (**Table 6**). Problematic online race bettors were significantly more likely to be male, younger, speak a language other than English at home, gamble on races more frequently, engage in more forms of gambling, self-report as a semi-professional or professional gambler, use drugs whilst gambling, and have a more negative attitude toward gambling.

Comparisons between Problematic Online EGM Gamblers, Problematic Online Race Bettors and Problematic Online Sports Bettors

The following analyses identify distinguishing characteristics between problematic online EGM gamblers, problematic online race bettors and problematic online sports bettors.

Bivariate Analyses

Demographics

Problematic online sports bettors and race bettors were significantly more likely to be male, have a tertiary degree and have higher incomes compared to problematic online EGM gamblers. Problematic online sports bettors were significantly younger compared to both problematic online EGM gamblers

and problematic online race bettors. Problematic online sports bettors were significantly less likely to be born in Australia, and significantly more likely to speak a language other than English at home compared to problematic online race bettors, with problematic online EGM gamblers not significantly different to either of the other groups on these variables (**Table 7**).

Gambling behavior

Problematic online EGM gamblers were significantly more likely to participate in more forms of gambling compared to both problematic online sports bettors and race bettors, and were significantly more likely to use illicit drugs when gambling compared to both of these groups. Problematic online EGM gamblers were also significantly more likely to drink alcohol at least sometimes when gambling compared to problematic online sports bettors. No significant differences were observed in terms of self-rated professional gambling status. Problematic online EGM gamblers had significantly higher PGSI scores compared to problematic online race bettors, with problematic online sports bettors not significantly different to either group.

Psychological variables

Problematic online EGM gamblers were significantly more likely to be experiencing high psychological distress compared

TABLE 1 | Bivariate analyses comparing non-problematic and problematic online EGM gamblers.

Variable	Non-problematic online EGM gamblers ($n = 64$)	Problematic online EGM gamblers ($n = 98$)	Inferential statistics
Demographics			
Gender (% male)	68.8	71.4	$\chi^2(1, N = 162) = 0.13, p = 0.715$
Age (Mean/SD)	39.6 (15.3)	36.8 (12.7)	$F(1,160) = 1.59, p = 0.209$
Education (% with degree)	34.4*	15.3	$\chi^2(1, N = 162) = 7.99, p = 0.005, \Phi = 0.22$
Work status (% working)	68.8	76.5	$\chi^2(1, N = 162) = 1.20, p = 0.273$
Income ($000's, Mean, *SD*)	86.1* (42.7)	65.8 (42.7)	$F(1,144) = 7.72, p = .006, \eta^2 = 0.05$
Country of birth (% Australia)	75.0	83.7	$\chi^2(1, N = 162) = 1.84, p = 0.175$
Main language spoken at home (% English)	85.9	88.8	$\chi^2(1, N = 162) = 0.29, p = 0.591$
Gambling behaviour variables			
Frequency of gambling on EGMs in last 12 months (median)	2.0	4.0*	*Mann–Whitney* $U = 1897.5, p < 0.001$
Percentage of EGM gambling online in last 12 months (median)	50	60	*Mann–Whitney* $U = 576.5, p = 0.070$
Number of forms in last 12 months (mean, *SD*)	5.2 (2.0)	5.7 (1.8)	$F(1,160) = 2.55, p = 0.112$
Gambler status			$\chi^2(2, N = 162) = 1.01, p = 0.605$
Professional	0.0	1.0	
Semi-professional	9.4	12.2	
Amateur (%)	90.6	86.7	
Alcohol use when gambling (% at least sometimes)	57.8	77.6*	$\chi^2(1, N = 162) = 7.15, p = 0.007, \Phi = 0.21$
Drug use when gambling (% at least sometimes)	6.3	23.5*	$\chi^2(1, N = 162) = 8.27, p = 0.004, \Phi = 0.23$
Psychological variables			
Kessler 6 (grouped, % high psychological distress)	0.0	21.4*	$\chi^2(1, N = 162) = 15.76, p < 0.001, \Phi = 0.31$
Kessler 6 score (mean, *SD*)	1.8 (3.1)	7.4* (6.3)	$F(1,160) = 43.11, p < 0.001, \eta^2 = 0.21$
Attitudes toward gambling (mean, *SD*)	1.2* (1.3)	0.7 (1.0)	$F(1,160) = 6.03, p = 0.015, \eta^2 = 0.04$

Asterisks indicate a significantly higher mean, proportion or median in that row.

TABLE 2 | Logistic regression predicting non-problematic online EGM gamblers compared to problematic online EGM gamblers.

Variable	*B*	*SE*	Wald	*p*	OR	95% C.I. for OR	
						Lower	Upper
Education (ref = tertiary)	**1.03**	**0.44**	**5.50**	**0.019**	**2.80**	**1.18**	**6.63**
EGM gambling frequency	**0.39**	**0.12**	**11.10**	**0.001**	**1.47**	**1.17**	**1.84**
Alcohol use while gambling (ref = no)	**0.97**	**0.40**	**5.81**	**0.016**	**2.63**	**1.20**	**5.79**
Drug use while gambling (ref = no)	**1.21**	**0.62**	**3.89**	**0.049**	**3.37**	**1.01**	**11.24**
Gambling Attitudes	−0.25	0.16	2.41	0.120	0.78	0.57	1.07
Constant	*−2.16*	*0.64*	*11.35*	*0.001*	*0.11*		

Non-problematic online EGM gamblers coded as 0, problematic online EGM gamblers coded as 1. Therefore, positive coefficients indicate that a higher score on that variable is associated with problematic online EGM gamblers. Bold text indicates a significant predictor. Income was not included due to missing data, and Kessler 6 was not included due to a high correlation with the PGSI.

to problematic online race bettors, and also to have higher K6 scores, with problematic online sports bettors being not significantly different to either group. Problematic online EGM gamblers were significantly more likely to agree that gambling harms outweighed benefits compared to problematic online sports bettors, with problematic online race bettors not significantly different to either group (**Table 7**).

Problematic online sports bettors were significantly more likely to state that their problems emerged after they first gambled online. Problematic online EGM gamblers were significantly more likely to think they needed help in relation to their gambling compared to problematic online sports bettors, and were significantly more likely to have sought help compared to problematic online sports and race bettors.

TABLE 3 | Bivariate analyses comparing non-problematic and problematic online sports bettors.

Variable	Non-problematic online sports gamblers ($n = 1213$)	Problematic online sports gamblers ($n = 181$)	Inferential statistics
Demographics			
Gender (% male)	90.4	98.3*	$\chi^2(1, N = 1394) = 12.61, p < 0.001, \Phi = 0.10$
Age (Mean/*SD*)	41.3* (14.0)	31.1 (9.8)	$F(1,1392) = 88.58, p < 0.001, \eta^2 = 0.06$
Education (% with degree)	42.9	44.8	$\chi^2(1, N = 1394) = 0.23, p = 0.633$
Work status (% working)	79.2	77.3	$\chi^2(1, N = 1394) = 0.33, p = 0.563$
Income ($000's, Mean, *SD*)	91.9* (44.6)	82.3 (49.4)	$F(1,1254) = 6.33, p = 0.012, \eta^2 = 0.01$
Country of birth (% Australia)	84.4*	76.2	$\chi^2(1, N = 1394) = 7.59, p = 0.006, \Phi = 0.07$
Main language spoken at home (% English)	93.1*	77.9	$\chi^2(1, N = 1394) = 44.75, p < 0.001, \Phi = 0.18$
Gambling behaviour variables			
Frequency of gambling on sports in last 12 months (median)	4.0	6.0*	*Mann–Whitney* $U = 56829, p < 0.001$
Percentage of sports gambling online in last 12 months (median)	100*	98.0	*Mann–Whitney* $U = 92808.5, p = 0.012$
Number of forms in last 12 months (mean, *SD*)	4.5 (1.7)	4.6 (2.2)	$F(1,1392) = 0.92, p = 0.337$
Gambler status			$\chi^2(2, N = 1394) = 44.75, p < 0.001, \Phi = 0.18$
Professional	2.3	3.3	
Semi-professional	8.0	16.0*	
Amateur (%)	89.7*	80.7	
Alcohol use when gambling (% at least sometimes)	67.7	64.1	$\chi^2(1, N = 1394) = 0.92, p = 0.336$
Drug use when gambling (% at least sometimes)	3.5	8.8*	$\chi^2(1, N = 1394) = 10.89, p = 0.001, \Phi = 0.09$
Psychological variables			
Kessler 6 (grouped, % high psychological distress)	0.7	12.7*	$\chi^2(1, N = 1394) = 105.14, p < 0.001, \Phi = 0.28$
Kessler 6 score (mean, *SD*)	1.7 (2.6)	6.4* (5.3)	$F(1,1392) = 351.27, p < 0.001, \eta^2 = 0.20$
Attitudes toward gambling (mean, *SD*)	1.4* (1.2)	1.1 (1.0)	$F(1,1392) = 9.56, p = 0.002, \eta^2 = 0.01$

Asterisks indicate a significantly higher mean, proportion or median in that row.

TABLE 4 | Logistic regression predicting non-problematic online sports bettors compared to problematic online sports bettors.

Variable	*B*	*SE*	Wald	*p*	OR	95% C.I. for OR	
						Lower	Upper
Gender (ref = female)	**1.35**	**0.63**	**4.61**	**0.032**	**3.85**	**1.13**	**13.20**
Age (in years)	**−0.07**	**0.01**	**59.71**	**<0.001**	**0.93**	**0.92**	**0.95**
Country of birth (ref = not Australia)	**−0.57**	**0.25**	**5.27**	**0.022**	**0.57**	**0.35**	**0.92**
Main language at home (ref = language other than English)	**−0.66**	**0.28**	**5.67**	**0.017**	**0.52**	**0.30**	**0.89**
Sports betting frequency	**0.65**	**0.08**	**69.92**	**<0.001**	**1.91**	**1.64**	**2.23**
% sports betting online	−0.00	0.01	0.04	0.851	1.00	0.99	1.01
Professional status (ref = amateur)			1.58	0.453			
Semi-professional	0.24	0.58	0.17	0.682	1.27	0.41	3.99
Professional	0.50	0.55	0.84	0.358	1.65	0.57	4.84
Drug use while gambling (ref = no)	0.15	0.38	0.16	0.689	1.17	0.55	2.47
Gambling attitudes	**−0.33**	**0.09**	**14.53**	**<0.001**	**0.72**	**0.60**	**0.85**
Constant	*−2.98*	*1.063*	*7.86*	*0.005*	*0.05*		

Non-problematic online sports bettors coded as 0, problematic online sports bettors coded as 1. Therefore, positive coefficients indicate that a higher score on that variable is associated with problematic online sports bettors. Bold text indicates a significant predictor. Income was not included due to missing data, and Kessler 6 was not included due to a high correlation with the PGSI.

Multivariate Analyses

In order to account for any overlap between the bivariate analyses comparing problematic online EGM gamblers, sports bettors and race bettors, we conducted three separate binary logistic regressions. The first compared problematic online EGM gamblers to problematic online sports bettors; the second compared problematic online EGM gamblers to problematic online race bettors; and the third compared problematic online sports bettors to problematic online race bettors.

TABLE 5 | Bivariate analyses comparing non-problematic and problematic online race bettors.

Variable	Non-problematic online race bettors ($n = 1145$)	Problematic online race bettors ($n = 291$)	Inferential statistics
Demographics			
Gender (% male)	88.8	96.2*	$\chi^2(1, N = 1436) = 14.53, p < 0.001, \Phi = 0.10$
Age (Mean/SD)	43.5* (14.4)	39.0 (12.8)	$F(1,1434) = 23.82, p < 0.001, \eta^2 = 0.02$
Education (% with degree)	41.4*	35.4	$\chi^2(1, N = 1436) = 3.48, p = 0.062, \Phi = 0.15$
Work status (% working)	77.6	81.1	$\chi^2(1, N = 1436) = 1.64, p = 0.201$
Income ($000's, Mean, *SD*)	91.4* (44.8)	84.4 (43.7)	$F(1,1310) = 5.33, p = 0.021, \eta^2 = 0.01$
Country of birth (% Australia)	85.0	89.7*	$\chi^2(1, N = 1436) = 4.26, p = 0.039, \Phi = 0.05$
Main language spoken at home (% English)	94.5*	89.7	$\chi^2(1, N = 1436) = 8.85, p = 0.003, \Phi = 0.08$
Gambling behavior variables			
Frequency of gambling on races in last 12 months (median)	4.0	6.0*	*Mann–Whitney* $U = 90515.5, p < 0.001$
Percentage of race betting online in last 12 months (median)	95.0*	90.0	*Mann–Whitney* $U = 141509, p = 0.012$
Number of forms in last 12 months (mean, *SD*)	4.5 (1.7)	4.9* (1.8)	$F(1,1434) = 13.80, p < 0.001, \eta^2 = 0.01$
Gambler status			$\chi^2(2, N = 1436) = 7.58, p = 0.023, \Phi = 0.07$
Professional	2.4	0.7	
Semi-professional	8.4	12.4*	
Amateur (%)	89.2	86.9	
Alcohol use when gambling (% at least sometimes)	67.6	73.2	$\chi^2(1, N = 1436) = 3.38, p = 0.066$
Drug use when gambling (% at least sometimes)	3.0	9.3*	$\chi^2(1, N = 1436) = 22.71, p < 0.001, \Phi = 0.13$
Psychological variables			
Kessler 6 (grouped, % high psychological distress)	0.5	11.7*	$\chi^2(1, N = 1436) = 106.71, p < 0.001, \Phi = 0.27$
Kessler 6 score (mean, *SD*)	1.6 (2.5)	5.1* (5.0)	$F(1,1434) = 284.00, p < 0.001, \eta^2 = 0.17$
Attitudes toward gambling (mean, *SD*)	1.4* (1.2)	1.0 (1.0)	$F(1,1434) = 30.04, p < 0.001, \eta^2 = 0.02$

Asterisks indicate a significantly higher mean, proportion or median in that row.

TABLE 6 | Logistic regression predicting non-problematic online race bettors compared to problematic online race bettors.

	B	*SE*	Wald	Sig.	OR	95% C.I. for OR	
						Lower	Upper
Gender (ref = female)	**0.81**	**0.36**	**4.90**	**0.027**	**2.24**	**1.10**	**4.57**
Age (in years)	**−0.04**	**0.01**	**33.33**	**<0.001**	**0.97**	**0.96**	**0.98**
Education (ref = tertiary)	0.15	0.16	0.86	0.355	1.16	0.85	1.57
Country of birth (ref = not Australia)	0.35	0.25	2.01	0.156	1.42	0.87	2.31
Main language at home (ref = language other than English)	**−0.74**	**0.29**	**6.57**	**0.010**	**0.48**	**0.27**	**0.84**
Race betting frequency	**0.60**	**0.06**	**116.49**	**<0.001**	**1.82**	**1.64**	**2.03**
% of race betting online	0.02	0.00	3.66	0.056	1.01	1.00	1.01
Number of forms engaged in	**0.11**	**0.05**	**5.36**	**0.021**	**1.11**	**1.02**	**1.21**
Professional status (ref = amateur)			**6.48**	**0.039**			
Semi-professional	**1.63**	**0.78**	**4.34**	**0.037**	**5.09**	**1.10**	**23.54**
Professional	**1.84**	**0.76**	**5.91**	**0.015**	**6.30**	**1.43**	**27.81**
Drug use while gambling (ref = no)	**0.70**	**0.33**	**4.65**	**0.031**	**2.02**	**1.07**	**3.82**
Gambling attitudes	**−0.44**	**0.07**	**36.65**	**<0.001**	**0.64**	**0.56**	**0.74**
Constant	*−5.44*	*1.04*	*27.59*	*<0.001*	*0.01*		

Non-problematic online race bettors coded as 0, problematic online race bettors coded as 1. Therefore, positive coefficients indicate that a higher score on that variable is associated with problem online race bettors. Bold text indicates a significant predictor. Income was not included due to missing data, and Kessler 6 was not included due to a high correlation with the PGSI.

The predictors included in each regression were the variables that showed significant differences for each comparison. For example, attitudes toward gambling differed significantly between problematic online EGM gamblers and problematic online sports bettors, and was thus included in the first regression. However, problematic online race bettors did not differ significantly to either of the other groups, and thus this variable was not included in either of the other regression analyses.

For the regression comparing problematic online EGM gamblers and problematic online sports bettors, gender was an issue, as only three problematic online sports bettors were female, and thus was virtually constant for that group. Gender was therefore dropped from the regression.

Logistic regression: problematic online EGM gamblers vs. problematic online sports bettors

The model was significant [$\chi^2(9, N = 279) = 66.52, p < 0.001$] and correctly predicted 68.8% of the sample. Compared to problematic online EGM gamblers, problematic online sports bettors were significantly younger, more educated, and engaged in significantly fewer forms of gambling (**Table 8**).

Logistic regression: problematic online EGM gamblers vs. problematic online race bettors

The model was significant [$\chi^2(6, N = 389) = 88.52, p < 0.001$] and correctly predicted 75.8% of the sample. Compared to problematic online EGM gamblers, problematic online race bettors were significantly more likely to be male, have higher education, gamble on fewer forms, and were significantly less likely to use illicit drugs when gambling (**Table 9**).

Logistic regression – problematic online sports bettors vs. problematic online race bettors

The model was significant [$\chi^2(3, N = 472) = 73.01, p < 0.001$] and correctly predicted 65.9% of the sample. Compared to problematic online sports bettors, problematic online race bettors were significantly older and significantly more likely to be born in Australia (**Table 10**).

DISCUSSION

This paper is the first to our knowledge to identify risk factors specific to problematic gambling on three popular forms of online gambling – EGMs, race betting and sports betting. While previous studies have identified risk factors for problem gamblers who engage in Internet gambling (e.g., McBride and Derevensky, 2009; Wood and Williams, 2009; Potenza et al., 2011; Hing et al., 2016e), these analyses have not considered whether or not their gambling problems are related to specific gambling forms and to engaging with them online. Using that approach may cloud results, given that online problem gamblers are often mixed-mode gamblers who gamble on multiple forms (Wardle et al., 2011; Gainsbury et al., 2015a). The current paper sought to provide a more accurate assessment of these risk factors by considering only individuals whose gambling problems reportedly stemmed from online gambling and from the specified gambling form.

In relation to online EGM gambling, only a few risk factors emerged that distinguished problematic from non-problematic players. Not surprisingly, more frequent online EGM gambling increased the risk of gambling problems, which aligns with findings from risk curve analyses based on several large representative datasets in Canada (Currie et al., 2006, 2008). Those analyses found that the risk of gambling problems increases steadily with frequency of EGM gambling and with the percentage of income spent on gambling. The latter association may also explain why lower income was also a risk factor for the problematic online EGM gamblers in our study. Other distinguishing risk factors were higher likelihood of using alcohol or illicit drugs while gambling, reflecting the greater prevalence of substance use amongst problem gamblers generally (Welte et al., 2004; Blanco et al., 2006; Dannon et al., 2006; Petry, 2007; Castrén et al., 2013). Of potential concern is that being able to gamble online in private may increase the ease of substance use while gambling, which may undermine rational decision-making. However, further research is needed to ascertain whether substance use amongst problem gamblers is more frequently associated with online compared to land-based EGM gambling. Of particular note is that nearly one-quarter of problematic online EGM gamblers reported at least sometimes using illicit drugs while gambling. Thus, the solitary and private character of online EGM play may facilitate long continuous sessions, in which alcohol and drugs are more likely to be consumed. The convenient access to internet gambling at any time of the day facilitates intense use among other work and familial commitments, and presumably helps to conceal the activity from significant others (Gainsbury et al., 2015b). These features would reasonably contribute to greater potential for the development of problems. Future research could profitably focus on comparing the timing and duration of online play sessions between problem and recreational online gamblers.

Our bivariate analyses indicated that problematic online EGM gamblers were significantly more likely to be experiencing psychological distress, compared to non-problematic online EGM players. This result parallels findings for problem gamblers who play land-based EGMs, and who frequently report doing so to escape negative mood states (Blaszczynski and Nower, 2002; Thomas et al., 2009; Nower and Blaszczynski, 2010). Individuals motivated to alleviate psychological distress may find online EGM gambling to be a more attractive escape mechanism, as it is more convenient and less socially demanding than attending a physical venue. The privacy and lack of distractions or interruptions provided by online EGM gambling is likely to contribute to immersion and dissociation – cognitive states thought be associated with 'escape oriented' problem gamblers – and which facilitate excessive gambling (Griffiths and Parke, 2002; Griffiths, 2003; Monaghan, 2009; Corney and Davis, 2010). Additional research is needed to test this proposition.

The above findings suggest that interventions for problem online EGM players need to discourage frequent gambling on this activity and substance use while gambling. In domestic venues, steps might conceivably be taken by staff to monitor and

TABLE 7 | Descriptive statistics and inferential tests for demographic variables by most problematic online gambling form.

Variable	Problematic online EGM gamblers ($n = 98$)	Problematic online sports bettors ($n = 181$)	Problematic online race bettors ($n = 291$)	Inferential statistics
Demographics				
Gender (% male)	71.4a	98.3b	96.2b	$\chi^2(2, N = 570) = 78.69, p < 0.001, \Phi = 0.37$
Age (Mean/SD)	36.8a (12.7)	31.1b (9.8)	39.0a (12.8)	$F(2,567) = 25.46, p < 0.001, \eta^2 = 0.08$
Education (% with degree)	15.3a	44.8b	35.4b	$\chi^2(2, N = 570) = 24.32, p < 0.001, \Phi = 0.21$
Work status (% working)	76.5	77.3	81.1	$\chi^2(2, N = 570) = 1.43, p = 0.489$
Income ($000's, Mean, *SD*)	65.7a (42.4)	81.7b (49.6)	83.8b (44.3)	$F(2,535) = 5.66, p = 0.004, \eta^2 = 0.02$
Country of birth (% Australia)	83.7a,b	76.2b	89.7a	$\chi^2(2, N = 570) = 15.36, p < 0.001, \Phi = 0.16$
Main language spoken at home (% English)	88.8a,b	77.9b	89.7a	$\chi^2(2, N = 570) = 13.59, p = 0.001, \Phi = 0.15$
Gambling behavior				
Number of forms in last 12 months (mean, *SD*)	5.7a (1.8)	4.6b (2.2)	4.9b (1.8)	$F(2,567) = 9.84, p < 0.001, \eta^2 = 0.03$
Gambler status				$\chi^2(2, N = 570) = 6.92, p = 0.140$
Professional	1.0a	3.3a	0.7a	
Semi-professional	12.2a	16.0a	12.4a	
Amateur (%)	86.7a	80.7a	86.9a	
PGSI (mean, *SD*)	9.5a (6.0)	8.3ab (4.6)	7.4b (4.6)	$F(2,567) = 7.55, p = 0.001, \eta^2 = 0.03$
Alcohol use when gambling (% at least sometimes)	77.6a	64.1b	73.2a,b	$\chi^2(2, N = 570) = 6.93, p = 0.031, \Phi = 0.11$
Drug use when gambling (% at least sometimes)	23.5a	8.8b	9.3b	$\chi^2(2, N = 570) = 16.36, p < 0.001, \Phi = 0.17$
Psychological variables				
Kessler 6 (grouped, % high psychological distress)	21.4a	12.7ab	11.7b	$\chi^2(2, N = 570) = 6.11, p = 0.047, \Phi = 0.10$
Kessler 6 score (mean, *SD*)	7.4a (6.3)	6.4ab (5.3)	5.1b (5.0)	$F(2,567) = 8.24, p < 0.001, \eta^2 = 0.03$
Attitudes toward gambling (mean, *SD*)	−1.27a (0.96)	−0.90b (0.99)	−1.00a,b (1.04)	$F(2,567) = 4.33, p = 0.014, \eta^2 = 0.02$
Problems emerged after you first gambled online (% after)	41.8a	64.4b	51.6a	$\chi^2(2, N = 540) = 12.97, p = 0.002, \Phi = 0.16$
Thought you needed help in relation to your gambling (% yes)	54.1a	35.9b	44.0a,b	$\chi^2(2, N = 570) = 8.72, p = 0.013, \Phi = 0.12$
Ever sought help (% yes)	46.9a	31.5b	27.5b	$\chi^2(2, N = 570) = 12.77, p = 0.002, \Phi = 0.15$

Subscripts indicate pairwise comparisons (tests of proportions for all variables apart from age, which are Tukey tests). Groups with the same letter are not significantly different from each other, and groups with two subscripts are not significantly different from either of the other groups. For example, for country of birth, a significantly higher proportion of problematic online race bettors was born in Australia compared to problematic online sports bettors (different subscripts), while problematic online EGM gamblers are not significantly different from either group. If no subscripts are present, no significant differences were observed.

intervene with patrons displaying these characteristics. However, in the case of online EGM providers, such measures are far more difficult to implement or enforce. High rates of psychological distress and higher PGSI scores in this cohort indicate that interventions involving professional treatment may be the most appropriate to address these underlying issues. In this study, a result of note is that the problematic online EGM gamblers were more likely to think they needed help for their gambling and to have sought help, than their race betting and sports betting counterparts. This increased ability of online EGM players to recognize they have a problem is understandable given the negative mood states more commonly associated with this form of play. The characteristics of problematic online EGM gamblers also suggest that interventions should target both genders and age groups from young to middle aged adults, and take into account the lower educational and income levels of this group. Interventions should also challenge beliefs that one can earn money from gambling, and discourage gambling on multiple gambling activities. Importantly, three-fifths of this cohort had gambling problems before gambling online. Therefore it should be recognized that for most, internet gambling provides a mechanism to sustain a developing dependence, rather than necessarily representing a 'gateway' into problematic use. Nevertheless, current Australian regulations outlawing the provision of online EGMs to Australian residents appear prudent, although they remain easily accessible via offshore sites. Given that problem online EGM gamblers also tend to gamble in venues, interventions should also discourage heavy gambling on land-based forms.

Risk factors identified for problematic online sports betting were very similar to those for problematic online race betting. Compared to their non-problematic counterparts, the

TABLE 8 | Multivariate logistic regression results predicting problematic online EGM gamblers vs. problematic online sports bettors.

Variable	*B*	*SE*	Wald	*p*	OR	95% C.I. for OR	
						Lower	Upper
Age in years	**−0.05**	**0.01**	**14.59**	**<0.001**	**0.95**	**0.92**	**0.97**
Education (ref = non-tertiary)	**1.28**	**0.35**	**13.62**	**<0.001**	**3.59**	**1.82**	**7.08**
Number of forms engaged in	**−0.27**	**0.08**	**13.24**	**<0.001**	**0.76**	**0.66**	**0.88**
Professional status (ref = amateur)			0.52	0.771			
Semi-professional	0.28	0.42	0.45	0.503	1.32	0.58	3.01
Professional	0.35	1.13	0.10	0.757	1.42	0.16	12.96
PGSI score	−0.01	0.03	0.10	0.747	0.99	0.93	1.06
Thought they needed help (ref = no)	−0.14	0.36	0.15	0.697	0.87	0.43	1.75
Sought help (ref = no)	−0.43	0.33	1.73	0.188	0.65	0.34	1.24
Gambling attitudes	0.26	0.17	2.35	0.125	1.29	0.93	1.80
Constant	3.55	0.83	18.43	<0.001	34.72		

Problematic online EGM coded as 0, problematic online sports bettor coded as 1. Therefore, positive coefficients indicate that a higher score on that variable is associated with online sports bettors. Bold text indicates a significant predictor.

TABLE 9 | Multivariate logistic regression results predicting problematic online EGM vs. problematic online race bettors.

Variable	*B*	*SE*	Wald	*p*	OR	95% C.I. for OR	
						Lower	Upper
Gender (ref = female)	**2.55**	**0.42**	**36.36**	**<0.001**	**12.84**	**5.60**	**29.42**
Education (ref = non-tertiary)	**0.98**	**0.34**	**8.36**	**0.004**	**2.67**	**1.37**	**5.21**
Number of forms engaged in	**−0.28**	**0.08**	**14.00**	**<0.001**	**0.75**	**0.65**	**0.87**
PGSI score	−0.04	0.03	2.25	0.134	0.96	0.91	1.01
Drug use while gambling (ref = no)	**−0.79**	**0.36**	**5.00**	**0.025**	**0.45**	**0.23**	**0.91**
Sought help (ref = no)	−0.49	0.30	2.58	0.108	0.62	0.34	1.12
Constant	0.78	0.55	1.99	0.158	2.18		

Problematic online EGM coded as 0, problematic online race bettor coded as 1. Therefore, positive coefficients indicate that a higher score on that variable is associated with online race bettors. Bold text indicates a significant predictor.

TABLE 10 | Multivariate logistic regression results predicting problematic online sports bettors vs. problematic online race bettors.

Variable	*B*	*SE*	Wald	*p*	OR	95% C.I. for OR	
						Lower	Upper
Age in years	**0.06**	**0.01**	**43.45**	**<0.001**	**1.07**	**1.05**	**1.09**
Country of birth (ref = not Australia)	**1.16**	**0.30**	**14.72**	**<0.001**	**3.19**	**1.76**	**5.77**
Main language spoken at home (ref = not English)	0.46	0.29	2.43	0.119	1.58	0.89	2.81
Constant	−3.10	0.48	41.44	<0.001	0.05		

Problematic online sports bettors coded as 0, problematic online race bettors coded as 1. Therefore, positive coefficients indicate that a higher score on that variable is associated with online race bettors. Bold text indicates a significant predictor.

problematic online sports and race bettors were more likely to be male, younger, and to speak a language other than English at home. This younger male profile of online bettors with gambling problems has also been identified elsewhere (Hing et al., 2017). Being a young adult male has consistently been identified as a risk factor for problem gambling in general (Johansson et al., 2009; Williams et al., 2012; Hing et al., 2016d). Because online wagering is heavily marketed to this demographic, concerns have been raised that young, male Internet bettors face heightened risks of related gambling problems (Lamont et al., 2011; Milner et al., 2013). Mirroring the comments made above regarding EGM players, much may depend on the patterns of use exhibited by online sports betters. For example, if online betting is done sporadically, in a social context (e.g., watching a game together), then online play may represent no extra risk when compared to venue-based play. On the other hand, if online sports betting facilitates different patterns of use (e.g., solitary betting in extended sessions late at night), then this would provide further evidence that the online product presents a greater risk. At the present time, concerns appear to be justified, given that young men in particular are increasingly seeking treatment for difficulties in

controlling their online sports betting (Blaszczynski and Hunt, 2011).

Compared to the non-problematic online bettors, online bettors (both sports and race) with gambling problems were less likely to speak English at home. Problematic online sports bettors were less likely to have been born in Australia, while the opposite was true for problematic online race bettors. These findings imply that the problematic online sports bettors were more likely to be first generation migrants, and their race betting counterparts to be second generation migrants, from non-English speaking countries. This difference may partially reflect the older age of problematic online race bettors than sports bettors in this study. Regardless, these findings are consistent with ethnic minority status being a common risk factor for gambling problems (Raylu and Oei, 2004; Welte et al., 2004). It is possible, however, that the ethnic profiles of problematic online sports bettors and race bettors differ, and this is an avenue for further research.

Behavioral risk factors for online bettors in our sample included more frequent online betting, as also found by LaBrie and Shaffer (2011) in their analysis of online betting data provided by a wagering operator. Both problem and non-problem online betters used the Internet for a very large proportion of their play. Nevertheless, problematic online bettors were more likely to also bet offline than their non-problem counterparts. This may be partially explained by a preference among problem sports betters for in-play betting, which is illegal via the Internet in Australia, although it is legal via telephone and in land-based venues. Several studies have found in-play betting to be associated with gambling problems (Gray et al., 2012; Braverman et al., 2013; LaPlante et al., 2014; Hing et al., 2016e). It may be also explained by the general tendency of problematic gamblers to employ multiple forms and platforms for their gambling (Potenza et al., 2000).

The problematic online bettors also had a greater tendency than their non-problematic counterparts to consider themselves to be semi-professional gamblers, and for race bettors, professional gamblers. Previous research has found high rates of problem gambling amongst self-nominated professional gamblers, raising queries over whether self-identifying as a professional gambler is a common but misguided way to rationalize problem gambling (Hing et al., 2015a, 2016b). Browne et al. (2015) argue that race betters are prone to suffer from 'delusions of expertise,' due to intrinsic difficulties in self-assessing skill based on betting returns. The problematic online bettors were also more likely to use illicit drugs when gambling, compared to their non-problematic counterparts, while the problematic sports bettors exhibited higher psychological distress than did those without gambling problems. Given these effects mirror the results discussed above for online EGM play, it suggests that similar concerns regarding increased potential risk may also apply to online sports betting.

The preceding results for problematic online bettors imply that interventions need to particularly target young adult males, discourage frequent betting, in-play betting and illicit drug use while betting, and challenge beliefs that one can easily earn money from betting. Public health messages should be available in a range of community languages, given the ethnic diversity of this cohort. Professional treatment that caters for online sports bettors should be encouraged, given their relatively high PGSI scores and psychological distress. These interventions also need to take into consideration the relatively high educational qualifications and income of this group, and also their typical engagement with multiple gambling activities.

Several limitations of this study must be acknowledged. The non-random sample attained means that results may not generalize to the broader population of problematic online gamblers on each of the three forms examined; and the sample size for EGM gamblers was particularly small. The identification of most problematic gambling mode and most problematic gambling form relied on self-report, and the analyses were unable to take into account multiple modes and forms that might be causing gambling problems for some respondents. Further, the study was cross-sectional. While this was adequate to identify risk factors, causal directions between gambling problems and each risk factor could not be ascertained. Finally, some social desirability bias may be present given the survey relied on self-report about a sensitive and stigmatized issue (Hing et al., 2016a,c).

CONCLUSION

This study has identified a range of risk factors for problem and moderate risk gambling on online EGMs, online sports betting and online race betting. Prior studies have generally made comparisons between those who gamble online and those who do not. Because online betters are also likely to gamble more heavily on land-based forms, this has prevented strong inference regarding the likely instrumental role of online betting in contributing to problematic play. That is, to some degree online play may *reflect* greater gambling involvement, rather than necessarily drive the development of problems (Hing et al., 2014a). A strength of this study is that it is the first known analysis of risk factors for online gambling based on most problematic mode and most problematic form of gambling. This has enabled comparisons within the set of individuals who gamble online, between those who nominate online gambling as their most problematic form of play and those who do not. This has provided some insight into the risk factors associated with online play. Our interpretation of these effects is that online platforms represent a risk in providing an accessible, convenient, and private means to continuously access gambling products at any time of the day. The privacy inherent to home internet use facilitates the potential concurrent use of alcohol and drugs. Particularly for online EGM gamblers – who tend to be vulnerable to escape-oriented and dissociative motivations – these represent risk factors for excessive use and associated gambling problems.

The detailed pattern of risks tends to vary with regard to different online gambling forms, particularly for EGM

gambling when compared to sports betting and race betting. These differences point to the importance of developing and implementing interventions specifically for each online gambling form that are tailored to the characteristics and behaviors of those most at-risk of gambling problems on each of these activities. The findings suggest that interventions for online EGMs could include: general messages on EGM websites and in social marketing that warn of the risks of gambling while under the influence of substances, that challenge beliefs that one can earn money from gambling, and that discourage gambling on multiple gambling activities; dynamic messaging on EGM websites triggered by high frequency of EGM play; and the availability and promotion of limit setting functions on EGM websites that enable gamblers to better restrict their EGM play. These communications need to be tailored to those most at-risk, and to therefore target both genders, age groups from young to middle aged adults, and those from lower educational and income levels. For sports and race bettors, the findings suggest that interventions such as social marketing and warning messages on betting websites need to particularly target young adult males and be available in a range of community languages. These communications should discourage frequent betting, in-play betting and illicit drug use while betting, and challenge beliefs that one can easily earn money from betting. Frequent betting should also trigger dynamic warning messages, while limit setting functions need to be available and prominently promoted on betting websites. Professional treatment catering for online sports bettors should be available, given their relatively high PGSI scores and psychological distress.

AUTHOR CONTRIBUTIONS

NH helped to conceive and design the work, helped to organize the acquisition of data, interpreted the data, drafted the manuscript, approved the final version to be published, and agrees to be accountable for all aspects of the work. AR helped to conceive and design the work, helped to organize the acquisition of data, analyzed the data, critically revised the manuscript for important intellectual content, approved the final version to be published, and agrees to be accountable for all aspects of the work. MB helped with data analysis and interpretation, critically revised the manuscript for important intellectual content, approved the final version to be published, and agrees to be accountable for all aspects of the work.

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Economic Recession Affects Gambling Participation But Not Problematic Gambling: Results from a Population-Based Follow-up Study

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In October 2008, Iceland experienced the fastest and deepest financial crisis recorded in modern times when all three major banks went bankrupt in less than 2 weeks. The purpose of this follow-up study is to examine potential changes in participation in 12 different gambling types and in problem gambling before (time 1; year 2007) and after (time 2; year 2011) the economic collapse in 2008. The time between the first and second wave of data collection was 3.5 years. In total, 1,531 participants took part in the study, 688 males and 843 females. There was a considerable increase in past year gambling behavior from 2007 to 2011, mostly due to increased participation in lotto (National lotto and Viking lotto) but also in bingo, monthly lotteries (class lotteries with at least monthly draw) and scratch tickets. Only EGMs (electronic gaming machines) participation declined significantly between the two timepoints. Examining past year problematic gambling figures revealed that there were no changes in the prevalence figures between the year 2007 (1.2%) and 2011 (1.1%). Further examination revealed that those who reported financial difficulties due to the recession were more likely to buy lotto- or scratch tickets during the recession than those who were not financially affected by the crisis. These findings remained after controlling for background variables and baseline gambling activity (gambling in 2007). Overall, the findings of the follow-up study suggest that when people are experiencing financial difficulties during economic recessions, the possibility to improve their financial situation by winning large jackpots with low initial stakes becomes more enticing.

Keywords: gambling, problem gambling, prevalence, economic recession, longitudinal study

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INTRODUCTION

The global bank crisis of 2008 resulted in dramatic economic and political changes for the Icelandic population. Following the privatization of the three largest banks in the early 2000s, the economy experienced unprecedented growth rates, largely driven by the activities of the financial sector (Benediktsdottir et al., 2011). The assets of the three major banks grew sevenfold from the year 2003 to 2007, with a great influx of foreign capital pouring into the country and leading to the offering of easy loans to the public (Ragnarsdottir et al., 2013). Standard of living increased during this period and in spite of increasing household debts raised the expectation of the public toward

more prosperity in the years to come (Matthiasson, 2008; Ragnarsdottir et al., 2013). However, as this growth was mostly financed with short-term loans available to the banks on the international market, the financial situation of the banks became unsustainable when their availability dried up in the global bank crisis. In less than 2 weeks in October 2008, the three largest banks in Iceland went bankrupt and in the following months the majority of other financial institutions were bankrupted as well (Benediktsdottir et al., 2011; Schwartz, 2011; Bergman, 2014; Johnsen, 2014). In fact, Iceland experienced the fastest and deepest financial crisis recorded in modern times. Within a short period of time, the financial crisis wiped out the stock market, the national currency lost more than half its value, there was a sharp increase in inflation rates resulting in huge losses (for both businesses and the general public) and increases in both household debts (indexed to inflation rates) and in prices for domestic goods (Danielsson and Zoega, 2009; Benediktsdottir et al., 2011; Statistics Iceland, 2011).

The enormity of the Icelandic economic collapse and the following sharp decline in standard of living has challenged researchers to study the effects of a sudden economic crash on population behavior and well-being. For example, a longitudinal study on a national cohort of 3.755 adults who responded to a survey on health and lifestyles in 2007 (prior to the crisis) and again in 2009 showed that women reported increased signs of stress during the period, but the effect was not found for men (Hauksdottir et al., 2013). This finding concurs with an earlier study examining attendance at emergency departments in Reykjavik shortly after the economic meltdown in October 2008 (Guðjónsdóttir et al., 2012). It was found that compared to the same timeframe in 2006 and 2007 there was an increase in the total number of visits to the cardiac emergency department, particularly among women. Furthermore, a study on sickness and sickness absence among 2.356 employees within the educational (teachers and kindergarten teachers) and care services (elderly and disabled care) revealed that sickness and sickness absence increased substantially over a 3-year period (2010–2013), but importantly more so within workplaces who had been subjected to downsizing during the financial crisis (Sigursteinsdóttir and Rafnsdóttir, 2015).

Gambling and Recessions

Within the gambling literature empirical studies on the effects of economic recessions on gambling patterns are lacking and existing approaches are mainly based on aggregated expenditure or sales data. For example, results from studies in the United States suggest that economic recession results in decreased participation in casino type games (including EGMs-electronic gaming machines) but at the same time in stable or even increased lottery sales (Horváth and Paap, 2012; Lyons, 2013). More recently, two studies from Sweden and Ireland using repeated cross-sectional household data (collected before and after the most recent economic recession) show similar findings (Rude et al., 2014; Eakins, 2016). The study from Sweden, using household data on general gambling expenditure collected in 2003 and again in 2009, found that the decision to gamble was affected by the recession (Rude et al., 2014). The Irish findings showed that bookmaker/toto participation was hampered during the recession, but lottery participation was not (Eakins, 2016). In general, these studies suggest that lotteries are recession-resistant but casino type games (including EGMs) and bookmaker betting are not. However, it has to be kept in mind that the evidence is only based on aggregated sales or expenditure data on relatively few gambling types. Such aggregated data does not offer the opportunity to examine directly if individual financial difficulties are related to changes in gambling behavior during an economic recession.

A repeated cross-sectional gambling study, incorporating data from both before and after the Icelandic economic meltdown in 2008 ($N = 8.249$), examined the effects of the economic crisis on participation in 11 different types of gambling as well as problem gambling (Olason et al., 2015). Firstly, the findings revealed a modest increase in problematic gambling over the study period, but further examination of the data suggested that this was most likely due to an increase in card and Internet gambling among young men. More interestingly, the main findings suggested a general increase in past year gambling within the Icelandic population which extended to most types except betting on the outcome of sport events, skill games and EGMs. In fact, a significant reduction in participation was only found for EGMs gambling. In contrast, the most notable increase in gambling participation was observed for the most popular gambling type, lotto. Further analyses, examining the association between financial difficulties and gambling, revealed that those participants who experienced financial problems due to the economic crisis were 52% more likely to have bought a lottery ticket during the recession period compared to those who were not affected financially by the crisis. Thus, this study extended the findings from the United States (Horváth and Paap, 2012; Lyons, 2013), Sweden (Rude et al., 2014), and Ireland (Eakins, 2016) by not only examining more types of gambling but also by addressing the individual effects of economic hardship on gambling during an economic crisis directly. In general, it also replicated the common finding that lotteries seem recession-resistant but EGMs do not.

Main Aims of the Present Study

It is notable that all existing studies that have examined the potential effects of economic crisis on gambling behavior so far are based on repeated cross-sectional study designs. Therefore, the estimates for change over time are based on comparisons of data from different samples collected at different time points. Consequently, a cross-sectional study design cannot exclude the possibility that changes over time might be partly or totally explained with inter-individual differences in reaction or experience toward certain events, such as an economic crisis. This problem is avoided using a longitudinal design as it allows for the study of intra-individual changes in gambling behavior between different time points, following the same people. In general, a longitudinal study design provides a more sensitive test of the effects

of a macro-environmental event, such as a major economic crisis, compared to a repeated cross-sectional study design (Slutske, 2007).

The economic crisis in Iceland therefore created a unique opportunity to examine the effects of the economic collapse on gambling behavior using two study designs, a repeated cross-sectional as well as a longitudinal one. Thus, in 2011 two studies were conducted, a third cross-sectional study and the present follow-up study on participants who had taken part in a gambling study from 2007. This gave us the possibility to compare findings on changes in gambling behavior from 2007 to 2011 between two different research designs (see Olason et al., 2015, for the results of the repeated cross-sectional study). Using follow-up data, the main aim of this study is to examine the potential changes in gambling participation and problematic gambling among the Icelandic population before (2007) and after (2011) the economic crisis in 2008. The same methodology and measures for gambling and problem gambling were applied at both time points. *A priori*, we expected to replicate the previous findings of Olason et al. (2015) with a general increase in total gambling figures that will extend to most gambling types, except EGMs. Secondly, Olason et al. (2015) reported that those who experienced financial difficulties due to the economical collapse were more likely to buy lotto tickets during the economical crisis than those who were not financially affected by the crisis, and this effect held after adjusting for gender, age, and education. The longitudinal design of the present study offers a more stringent test of this finding by adjusting not only for gender, age and education but also for baseline levels (2007) of gambling activities. Finally, the study design also offers, for the first time, the chance to evaluate problem gambling trajectories in Iceland.

MATERIALS AND METHODS

Participants and Procedure

In 2007, a total of 3.004 18- to 70-year-old Icelanders drawn randomly from the National Registry participated in a national gambling study. Information was collected via telephone interviews conducted by trained interviewers at the Social Science Institute at the University of Iceland. Subsequently, respondents were invited to participate in a follow-up study at a later time. In total, 1.780 participants (59.2%) agreed to participate in the follow-up study. The data for the second wave was again collected by telephone by the Social Science Institute in 2011. In total, information was obtained from 1.531 participants or 86% of those who agreed to participate in the follow-up study. The time between the first and second wave of data collection was 3.5 years.

The study was carried out in accordance with the 1964 Helsinki Declaration and its later amendments. The study was reported to the Data Protection Authority of Iceland and in accordance with their recommendation we collected written informed consent from all participants in the follow-up study. Further, all participants were assured of confidentiality and anonymity and informed that they could withdraw their participation at any time or choose to not answer individual questions.

Instruments

The structured questionnaire included a total of 180 questions (not all relevant to the present study) that were presented to the participants as follows: First, participants were asked about their gambling behavior. If a participant had gambled at least once during the past 12 months in any gambling activity he was also presented with questions on problem gambling and motivations to gamble. Subsequently, a number of questions regarding gambling related-attitudes and his background (e.g., age, education, marital status, work, and income) were presented. At the end of the follow-up interview, the participants were asked questions regarding the effects of the economical collapse on their finances and well-being. The number of questions for each participant could vary depending on their gambling activities. On average each participant answered 55 questions.

(1) Gambling behavior: At both data collection points, gambling behavior was measured with the same methodology. First, respondents were asked if they had participated in a gambling type in the past 12 months and if they responded positively they were asked how frequently they had gambled in that gambling type on a scale ranging from 1 (few times in the last 12 months), 2 (one to three times a month), 3 (one to two times a week), 4 (three to six times a week), and 5 (daily). Participants were asked at both data collection points about their participation in licensed gambling activities such as lotto (National lotto and Viking lotto), scratch tickets, EGMs (electronic gaming machines), sport pools, sport betting (fixed odds sport betting on individual games), live sport betting (live betting on in-play events of sport events, e.g., the first corner in football matches), monthly lotteries (three class lotteries with monthly draws) and bingo: Also, participants were asked about their participation in non-licensed offline gambling activities such as poker (with cards), illegal casinos and betting on games of skill (e.g., billiard, golf, bowling). Finally, all participants were asked about their participation in non-licensed gambling activities on online international Internet gambling sites (e.g., scratch tickets, EGMs, sport betting (including both fixed odds sport betting and live sport betting), Internet poker and other casino gambling activities).

(2) Problem gambling: The Problem Gambling Severity Index (PGSI; Ferris and Wynne, 2001) is a nine-item instrument specifically devised to measure problem gambling in general populations. The time frame refers to the past 12 months and for each item, respondents answer on a four-point scale (0 = never, 1 = sometimes, 2 = most of the time and 3 = almost always). All respondents who gambled at least once during the past 12 months answered the PGSI. The total score ranges from 0 to 27 where a score from 8 or more signifies problem gambling, a score from 3 to 7, moderate risk gambling, a score from 1 to 2 low risk gambling and a score of 0 non-problem

gambling. To ensure comparability with the repeated cross-sectional study (Olason et al., 2015) we combined the moderate risk gambling and problem gambling groups into one group signifying problematic gambling (score 3+ on PGSI). Psychometric evaluations of the instrument in different cultures suggest that the PGSI is a reliable and valid measure of problem gambling (Ferris and Wynne, 2001; Holtgraves, 2009; Loo et al., 2011; Sharp et al., 2012). Two independent Icelandic translations of the PGSI were initially generated, the versions were then examined and one final version obtained. A professional translator retranslated the final version which was then compared to the original English version to ensure accuracy. The factor structure and reliability of the PGSI were examined in a sample of 1,266 university students and the results revealed a uni-dimensional scale with acceptable reliability ($\alpha = 0.84$) (Olason et al., 2003).

(3) Economic collapse: An effort was made to evaluate the influence of the economic collapse on participants' finances. However, due to the overall length of the questionnaire (180 questions), a detailed examination of this subject was not possible. Therefore, a decision was made to use one question on financial well-being obtained from Statistic Iceland that has been used in other national surveys on health and wellbeing of Icelanders during the economic collapse in Iceland as well (Statistics Iceland, 2011; Gudmundsdottir, 2013). Participants were asked about their financial difficulties in relation to the economic collapse during the last 12 months answering on a five-point scale ranging from 1 (very easy) to 5 (very difficult): "How easy or difficult has it been for you and/or your family to make ends meet financially every month, for example paying for accommodation, food and other monthly bills?"

Statistical Analysis

Initial analyses revealed that Internet participation on non-licensed Internet gambling sites was rather infrequent for different types of gambling: Therefore all questions on non-licensed Internet gambling were combined into one variable signifying total Internet gambling for both data collection points.

Initially, at baseline (year 2007) four age groups (18–25, 26–40, 41–55, and 56–70 years) were generated according to the convention in Icelandic gambling research reflecting different life cycles. However, due to the longitudinal nature of the present study, we added 3 years to each age brackets to reflect the increased age of participants at the follow-up (year 2011). Thus, the age groups were the following; 21–28, 29–43, 44–58, and 59–74 years.

A preliminary examination of the distribution of answers on the proxy question for the effects of the financial collapse indicated that 48.5% of participants found it easy (1 = very easy; 2 = rather easy) to make ends meet, 19.6% neither easy nor difficult (3 = neither/nor) and 31.5% found it difficult (4 = rather difficult; 5 = very difficult). To ensure comparability with the earlier repeated cross sectional study (Olason et al., 2015) and to differentiate clearly between the groups who either experienced financial difficulties or not, the middle category (those who found it neither easy or difficult) was excluded.

In order to check the association of the proxy variable (financial difficulties) with an increased probability of participation in certain types of gambling in 2011, successive logistic regression models were built up. In a first step, for each type of gambling, simple logistic regression models (model 1 – simple regression) were executed to predict the probability of participation in 2011 by the proxy in 2011. If a statistically significant association between the proxy and the gambling type existed, we also examined alternative explanations by complementing the simple predictive model with effects of gender, age and education (model 2 – adjusted for demographics) as well as by adding effects of past participation in the given type of gambling in 2007 (model 3 – adjusted for demographics and past behavior). If the proxy showed a statistically significant association with a type of gambling even after adjusting for demographic variables and past gambling behavior, there hardly remained any alternative explanation for the increased probability of participation in 2011 than the proxy itself. Changes in metric variables between 2007 and 2011 were analyzed with repeated analyses of variance, adjusted for inter-individual effects of gender, age, and education.

RESULTS

Changes in Gambling from 2007 to 2011

Trends in total gambling are shown in **Table 1**. The results reveal that gambling participation had increased, as an additional 10.7% of the sample reported gambling in 2011 compared to 2007. Further, there was also a significant increase in the number of gambling types played, rising from 1.3 games in 2007 to 1.6 games in 2011 [$t(1{,}530) = 10.08$, $p < 0.001$]. Trends for total gambling were similar for gender and educational

TABLE 1 | Total gambling trends over time by demographics.

	2007 %	2011 %	McNemar Chi-square	% Change
All participants (n = 1,531)	68.8	79.5	84.01***	+10.7
Gender				
Males (n = 689)	69.8	79.4	31.53***	+9.6
Females (n = 842)	67.9	79.6	51.69***	+11.7
Age groups				
21–28 (n = 156)	59.0	67.9	3.52	+8.9
29–43 (n = 468)	68.6	83.8	45.79***	+15.2
44–58 n = 565)	68.8	78.8	27.01***	+10.0
59–74 (n = 342)	73.4	80.1	9.87**	+6.7
Education				
Primary (n = 274)	74.1	84.3	15.19***	+10.2
Secondary (n = 589)	71.5	82.3	34.21***	+10.8
University (n = 655)	64.1	75.4	36.01**	+11.3

$^{**}p \leq 0.01$, $^{***}p \leq 0.001$.

levels but more variation was observed for different age groups (see **Table 1**).

In order to identify possible interaction effects between demographic variables and total gambling the data were entered into repeated measures mixed ANOVAs using a four point (0 = never gambled to 3 = gambled weekly) measurement for total gambling frequency as the dependent variable at time 1 and 2 and demographic variables as between group variables. The results revealed that the interaction was neither significant between time and gender [$F(1,1,529) = 0.684$, $p > 0.05$], nor between age groups [$F(3,1,527) = 0.480$, $p > 0.05$] or educational levels [$F(2,1,515) = 0.617$, $p > 0.05$]. However, the overall effects for between group analyses revealed significant differences for age groups [$F(3,1,527) = 11.060$, $p < 0.001$] and educational levels [$F(2,1,515) = 10.096$, $p < 0.001$] but not for gender [$F(1,1,529) = 1.507$, $p > 0.05$]. As can be seen in **Table 1**, at both time points the youngest age group was less likely to gamble than older age groups (2007: [$\chi(3,1,531) = 10.38$, $p < 0.05$]; 2011: [$\chi(3,1,531) = 18.24$, $p < 0.001$]). Further, those with university education were at both time points less likely to gamble than those with lower levels of education (2007: [$\chi(2,1,518) = 12.20$, $p < 0.01$]; 2011: [$\chi(2,1,518) = 13.55$, $p < 0.01$]).

We then explored in detail to what extent changes in gambling could be observed for different types of gambling (see **Table 2**). The greatest changes were found for lotto where an additional 16% of the sample reported buying lotto tickets in 2011 compared to 2007. Also, participating in bingo, monthly lotteries and buying scratch tickets was more common in 2011 than in 2007. Interestingly, a significant decrease was observed for EGMs.

To examine potential interaction effects between demographic variables and changes in gambling frequency in different gambling types the data were again entered into a series of repeated measures mixed ANOVAs using a four-point (0 = never gambled to 3 = gambled weekly) measurement for each gambling type as the dependent variable at both time points and demographic as between group variables. Live sport betting, illegal casinos, and Internet gambling were excluded from these analyses as too few individuals participated in these activities. Prior to these analyses the significance levels were adjusted for the high number of tested interaction effects ($n = 27$) using the Bonferroni correction, resulting in significance levels of $p \leq 0.001$.

The results revealed that the interactions between time and gender, time and educational levels and time and age groups were not significant for any of the different gambling types ($p > 0.001$).

TABLE 2 | Gambling trends over time for different gambling types.

	2007 %	2011 %	McNemar Chi-square	% Change
Lotto	49.7	65.7	154.64***	+16.0
Bingo	4.8	10.8	42.86***	+6.0
Monthly lottery	33.8	37.2	12.37***	+3.4
Scratch tickets	16.3	19.6	8.12**	+3.3
EGMs	7.3	4.8	13.93***	−2.5
Poker	5.1	5.6	0.39	+0.6
Football pools	6.3	6.9	0.86	+0.6
Sport betting	3.6	3.1	0.73	−0.5
Games of skill	1.6	1.6	0.0	0.0
Live sport betting	0.5	0.2	0.34#	−0.3
Illegal casinos[1]	0.3	0.3	1.00#	0.0
Internet gambling[2]	1.1	1.1	1.00#	0.0

[1]*Small underground establishments where you play mostly cash poker, black jack, or roulette.* [2]*Gambling on non-licensed international websites.* # *Binominal distribution used.* $^{**}p \leq 0.01$, $^{***}p \leq 0.001$.

Changes in Problematic Gambling

In 2007, 4.8% of all participants were low risk gamblers and 1.2% problematic gamblers (score 3+ on the PGSI). Figures were slightly lower in 2011 with 4.2% low risk gamblers and 1.1% problematic gamblers. To check for changes in levels of problem gambling we first calculated if the total scores on PGSI had changed from 2007 to 2011 and subsequently tested for interaction effects for background variables using repeated measures mixed ANOVAs. No overall change between PGSI scores from 2007 to 2011 was found [$t(1,529) = 1.378$, $p > 0.05$] and interaction effects with gender [$F(1,1,528) = 3.33$, $p > 0.05$], age groups [$F(3,1,526) = 0.477$, $p > 0.05$] and educational levels [$F(2,1,514) = 1.62$, $p > 0.05$] were all non-significant.

Subsequently, we examined the consistency of individual trajectories from 2007 to 2011 (see **Table 3**). Interestingly, there was a considerable shift over time for different gambling groups. Specifically, about half of those who did not gamble in 2007 did so in 2011 and 0.4% ($n = 2$) were found to be problematic gamblers. In fact, over half ($n = 9$) of those who had gambling-related problems in 2011 did not have any problems in 2007 (see column 5 in **Table 3**).

Consistency rates (figures are bolded in **Table 3**) were high for non-problematic gamblers with 88.6%, but little consistency was observed for the low risk and problematic gambling groups. Less than a third of those who had problems in 2007 were still categorized as such in 2011. Further, over 50% of those who were defined as problematic gamblers in 2007 had either quit gambling or gambled without any problems in 2011. Further examination of the data revealed that only one participant had

TABLE 3 | Consistency of individual trajectories of gambling groups.

	Gambling groups in 2011			
Gambling groups in 2007	**Non-gamblers *n* (%)**	**Non-problem gambling *n* (%)**	**Low risk gambling *n* (%)**	**Problematic gambling *n* (%)**
Non-gamblers	**238 (49.8)**	232 (48.5)	6 (1.3)	2 (0.4)
Non-problem gamblers	68 (7.1)	**851 (88.6)**	34 (3.5)	7 (0.7)
Low risk gamblers	7 (9.5)	42 (56.8)	**22 (29.7)**	3 (4.1)
Problematic gamblers	1 (5.6)	9 (50)	3 (16.7)	**5 (27.8)**

Consistency rates are presented in boldface.

received treatment for his gambling problems in 2007 and three reported having done so in 2011. Of those three individuals, two were categorized as non-problem gamblers and one was still a problematic gambler.

Effects of the Economic Crisis on Gambling and Problem Gambling

Initial analysis with regard to the relationship between financial difficulties and demographic variables revealed that females (44.6%) were more likely than males (32.6%) to report financial difficulties [$\chi(1,1,215) = 18.31$, $p < 0.001$], and those with primary education (53.0%) were more likely to report financial difficulties than those with secondary (38.7%) or university (34.3%) education [$\chi(2,1,208) = 22.61, p < 0.001$].

The results of the simple logistic regression analysis using financial difficulties as a predictor revealed that that those who experienced financial difficulties were more likely to have gambled at least once in 2011 (OR = 1.68, $p < 0.01$), to have bought lotto tickets (OR = 1.77, $p < 0.01$) and scratch tickets (OR = 1.55, $p < 0.01$) than those who did not experience any financial difficulties during the 12 months before the study (see model 1 in **Table 4**).

The results for the more restricted models revealed that even after controlling for gender, age, education, and past gambling behavior (model 3 in **Table 4**) the effects remained significant. All three final models showed a statistically significant increase of the log-likelihood-ratio ($p \leq 0.01$).

Finally, we tested if those who started gambling between the two time points (i.e., those who gambled in 2011 but not in 2007) were different from those who did not gamble at all (at neither time point) in terms of financial difficulties. The results showed that those who started to gamble between 2007 and 2011 were more likely to have difficulties to make ends meet (41.6%) than those who did not gamble (28.4%) at all [$\chi(1,380) = 7.23$, $p < 0.01$].

DISCUSSION

The sudden collapse of the three major banks in the beginning of October 2008 in Iceland started a major financial crisis in the country that dominated the public discussion in the media. The first 3 years of the crisis, from 2008 to 2011, thus consisted of substantial changes in the society, including considerable decreases in the living standards of the population. This situation not only led to increased distress, sickness, and sickness absence among employees subjected to downsizing (Snorradóttir et al., 2013; Sigursteinsdóttir and Rafnsdóttir, 2015), but also to changes in dietary habits, stress levels, and travel behavior of the population (McClure et al., 2013; Ásgeirsdóttir et al., 2014; Ulfarsson et al., 2015).

The economic crisis in Iceland therefore created a unique opportunity to also look at the effects of the economic collapse on gambling behavior using two study designs, a repeated cross-sectional study (Olason et al., 2015) and the present longitudinal study.

Gambling Behavior

As expected, the findings of the follow-up study in general confirmed the findings of the repeated cross-sectional study (Olason et al., 2015) showing a considerable increase in total gambling figures (about 11 percentage points), mostly due to increased participation in lotto (16 percentage points), but also in other types of lotteries such as bingo, monthly lotteries, and scratch tickets. Further, there were no changes in betting on the outcomes of sport events (sport pools, sport betting), poker or Internet gambling but a significant decrease in EGMs participation.

It is noteworthy that increases in gambling during economic recession was only found for lotteries (e.g., lotto, scratch cards, monthly lottery, and bingo) but not in other types of gambling. Further, examining potential gender differences in total gambling and in different gambling types over time revealed no significant

TABLE 4 | Odd ratios for financial difficulties.

Dependent variable	Model 1: Simple regressions	Model 2: Adjusted for demographics	Model 3: Adjusted for demographics and past gambling behavior
Total gambling	1.68** (1.25; 2.27)	1.64** (1.21; 2.23)	1.60** (1.13; 2.27)
Lotto	1.77** (1.38; 2.28)	1.76** (1.36; 2.28)	1.46* (1.08; 1.98)
Scratch tickets	1.55** (1.17; 2.06)	1.53** (1.14; 2.04)	1.41* (1.03; 1.94)
Poker	0.78ns (0.46–1.33)		
Football pools	0.94 ns (0.59; 1.49)		
Sport betting	1.01ns (0.52; 1.96)		
Monthly lotteries	1.01ns (0.79; 1.28)		
EGMs	1.04ns (0.61; 1.76)		
Games of skill	0.72ns (0.29; 1.78)		
Bingo	0.96ns (0.66; 1.39)		
Internet gambling	0.89ns (0.26; 3.04)		
Illegal casinos	3.11ns (0.28; 34.4)		
Live sport betting	0.00ns (0.00; 0.00)		
Problematic gambling	1.56ns (0.54–4.48)		

*ns, non-significant. *$p \leq 0.05$, **$p \leq 0.01$.*

differences for men and women. This lack of significant interaction effects can be explained by the fact that meaningful changes over time were only found for gambling types, where past studies have shown small or no differences between male and female participation (Olason, 2008, 2012; Olason et al., 2015). Participation in gambling types such as EGMs, sport gambling, Internet gambling, or poker, typically preferred by males, did, however, not change during the recession. Thus a lack of gender differences in changes of gambling participation over time is probably based on the fact that both genders equally increased their participation in gambling types that typically show little gender differences overall.

Considering individuals' decisions to gamble, it is likely that a number of factors influences this decision, including the choice of participating in particular gambling activities. Thus motivations for gambling may differ and can vary depending on individual preferences. Common motivations for gambling reported in the literature are related to winning money, entertainment, enjoyment, excitement, escape, social interaction, and supporting charities (Ariyabuddhiphongs, 2011; Binde, 2013). Other factors that also might be important are the time invested in the gambling activity, knowledge required to play the game and the perceived risks associated with a certain gambling type (Eakins, 2016). To gamble on sport events and poker requires both time and knowledge and earlier Icelandic studies have shown that people perceive EGMs, poker and sports gambling as more addictive than lotteries (Olason, 2008, 2012). Taken together, lotteries not only take a relatively short time to play and require little knowledge, but are also perceived of as low-risk gambling activities. In fact, lotteries are ubiquitous and thus individuals tend not to regard them as gambling, but rather as a form of a leisure activity (Ariyabuddhiphongs, 2011). Further, the added benefits of lotteries encompass that playing requires only a small initial stake and a possibility (although very small) of winning large jackpots. It is therefore perceivable that lotteries are regarded as a more acceptable type of gambling during recessions, when money is scarce. This is in fact supported by our findings: Participants who experienced financial difficulties during the recession were overall more likely to have bought lotto- or scratch tickets than those who did not experience financial difficulties. These results remained after controlling for demographics (gender, age, and education) and, more importantly, for past gambling activity. These findings therefore suggest that when people are experiencing financial difficulties during an economic recession they perceive the possibility to win large jackpots with low initial stakes as means to improve their financial situation. This line of argumentation is also supported by the finding that those who did not gamble in 2007 but did so in 2011 (new gamblers) were more likely to report financial difficulties than those who did not gamble at all.

The reported association between financial difficulties and lottery gambling found in the present study is further supported by empirical results of other studies that have also reported significant links between lottery play and income levels (Ariyabuddhiphongs, 2011; Barnes et al., 2011). For example, Welte et al. (2002) found in a household survey in the United States that the bottom three quintiles in socioeconomic status spent the most on the lottery and highest socioeconomic groups spent the least. Earlier, Kearny (2005) reported that with the introduction of state lotteries in the United States households expenditure on non-gambling items (e.g., food, clothes) declined and the response was most pronounced for low-income households. In additions, similar associations with income have been reported in the United Kingdom (Grun and McKeigue, 2000) and Thailand (Ariyabuddhiphongs, 2006).

In general, the changes in gambling behavior found in this study confirm the trends obtained from the repeated cross-sectional study and extend previous findings using sales and expenditure data (Horváth and Paap, 2012; Lyons, 2013; Rude et al., 2014; Olason et al., 2015; Eakins, 2016). Collectively, the results of these studies lead to the conclusion that during an economic recession people tend to continue or even increase their participation in lotteries but decrease their participation in casino type games, including EGMs.

Problem Gambling

No changes were observed for problematic gambling over time as figures remained just over 1% at both time points. A detailed examination, testing for interaction effects between time and different background variables also revealed no differences in problematic gambling over time for gender, age, or education. These findings are different from those obtained in the repeated cross-sectional study where problematic gambling rose from 1.6% in 2005/2007 to 2.5% in 2011. However, it is important to note that the increase in problematic gambling in that study was prominently found among 18- to 25-year-olds (see p. 765 in Olason et al., 2015). Thus, one probable reason for the differences between the studies might be linked to a maturing out effect for problem gambling. Empirical support for this idea can be found in longitudinal studies on youth to young adulthood (Slutske et al., 2003) or in a recent study from Sweden that showed a higher incidence rate for the age group 16 to 24 compared to 25- to 44-year-olds (Fröberg et al., 2015).

Stability of Problem Gambling Groups

Prior studies on the stability of problem gambling (tendency to stay at the same diagnostic level over time or intra-individual stability) in non-treatment samples suggest that instead of stability, problem gambling is a fluid condition with multidirectional pathways. That is, movement between problem gambling categories over time are rather common among all age groups, but more often in direction of improvement than worsening of symptoms (e.g., Slutske et al., 2003; Abbott et al., 2004; LaPlante et al., 2008; Delfabbro, 2013; Edgerton et al., 2015; Fröberg et al., 2015).

Although this was not one of the main aims of the present study, the prospective nature allowed us to examine the stability of problem gambling categories in a population-based sample over a 3.5-year period. The results indicate that, as expected, consistency was high for non-problem gamblers with close to 90% of non-problem gamblers in 2007 classified as non-problem gamblers again in 2011. However, the empirical evidence for low

risk- and problematic gamblers mirrors the relatively common finding of inconsistency in problem gambling classification over time as less than 30% of the gamblers classified in these groups in 2007 were classified in the same groups in 2011. The trend also suggested improvement rather than worsening in symptoms as the majority of low risk gamblers in 2007 had transferred to the non-problem gambling group (56.8%) or had stopped gambling (9.5%) 3.5 years later. Similarly, for the 2007 problematic gamblers more than half of the group were either gambling without problems (50%) or had quit gambling altogether (5.6%) in 2011. However, the overall problem gambling prevalence did not change over the 3.5-year time period due to the fact that some individuals showed a progression in symptoms from 2007 to 2011 toward problematic gambling (from the non-gambling group: $n = 2$, from the non-problem gambling group: $n = 7$ and from the low risk gambling group: $n = 3$). Taken together, these results, although only based on small case numbers, support prior findings suggesting that problematic gambling in non-treatment samples reflects a pattern of transition and, for the more severe cases, the general trend reflects a decrease instead of stability or an increase in gambling-related problems over time (e.g., LaPlante et al., 2008; Delfabbro, 2013; Edgerton et al., 2015).

There are some limitations of this study worth noting. Firstly, the data is based on self-reports that have the well-known potential limitations related to recall bias among respondents and the possibility that individuals are in general inclined to give deceptive or social desirable answers due to the sensitivity of survey questions. A second limitation refers to the fact that although we received a high retention rate from those who agreed to take part in the follow-up study (86%) the overall response rate from the total sample in 2007 was 51%. However, response rates in surveys among the general public are declining and retention rates in follow-up studies are dropping (e.g., Galea and Tracy, 2007; Arfken and Balon, 2011; Greenberg and Weiner, 2014). The same problem seems to apply to gambling studies (e.g., Williams et al., 2012; Romild et al., 2014; Billi et al., 2015; Meyer et al., 2015). For example, a recent meta-analytic study including 202 published and unpublished international gambling prevalence surveys from 1975 to 2012 found a significant negative association between survey year and response rates. Further, they reported an average response rate for studies using telephone interviews of only 52.5% (Williams et al., 2012). Although the overall response rate of the present study might seem low, it certainly does not differ from the average response rates of other gambling studies (see Williams et al., 2012) and more importantly its effect seems miniscule on gambling participation rates as the overall findings for gambling in the present study concur with the findings from the repeated cross-sectional study conducted over the same time period (Olason et al., 2015). However, the attrition rate are a matter of concern for the current study and other gambling studies with longitudinal design (e.g., Currie et al., 2011; Fröberg et al., 2015).

CONCLUSION

The present results show a considerable increase in gambling behavior over a 3.5-year period in Iceland, during one of the most deepest economic crisis in modern times. Certainly, a possible alternative explanation for this trend might be if there were some significant changes in the Icelandic gambling market during the time period of the study, such as new gambling products or increased gambling opportunities. However, the legal gambling market in Iceland remained stable throughout the period, that is no new gambling products were introduced and the availability of existing gambling products did not increase in any way (e.g., Olason and Gretarsson, 2009; Olason, 2012). Our conclusion therefore is that the finding that there is a strong temporal association between individual financial difficulties during such crisis and increased participation in lotto and scratch tickets and the fact that a higher percentage of new gamblers (started gambling during the economic crisis) report financial difficulties than non-gamblers bolster the claim that economic cycles (as a macrosocial factor) and individual gambling behavior are strongly related. Finally, the findings of this follow-up study also extend earlier evidence from repeated cross-sectional studies from Iceland, the United States, Sweden, and Ireland that collectively illustrate that lotteries are recession-resistant but casino gambling (including EGMs) and parimutuel betting are not. In future, longitudinal studies with a broader time frame between measurements need to be conducted to clarify the stability of this relationship.

AUTHOR CONTRIBUTIONS

All authors were actively involved with this research paper and all contributed to the writing of the paper. DO is responsible for the data collection, data analysis, and writing of the paper. TH was involved in the overall planning of data analysis and writing of the paper. GM was involved with the writing of the paper and overall planning of the data analysis. TB did statistical analysis and contributed to the writing of the paper.

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OPINION
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Does Telescoping Exist in Male and Female Gamblers? Does It Matter?

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INTRODUCTION

Sex/gender differences (hereafter termed "gender-related differences," with the understanding of the American Psychological Association's (2012) definitions of sex as a person's biological status such as male or female, and gender as the attitudes, feelings, and behaviors associated with biological sex) in gambling disorder (GD) have received relatively little investigation. Existing studies have shown that gender-related differences may exist in forms of gambling preferred and performed, disorder onset, co-occurring disorders and disorder progression, especially telescoping. Given existing data, we opine that understanding gender-related differences in telescoping, as well as other gender- and gambling-related phenomena, is critical for optimizing prevention and treatment strategies. With a focus on telescoping, this piece aims to opine on the importance of studying gender-related differences to better understand telescoping and for informing effective policy, prevention, and treatment efforts.

TELESCOPING

Several studies have found that women show a later initial engagement with GD but tend to progress more rapidly than men in developing an addictive disorder, a gender-related phenomenon known as telescoping (Potenza et al., 2001; Ladd and Petry, 2002; Tavares et al., 2003; Nelson et al., 2006; Grant et al., 2009, 2012c). Although the cause of the telescoping effect is not known, co-occurring disorders related to anxiety in women and alcohol use in men may not be as central as was previously hypothesized (Tavares et al., 2003; Odlaug et al., 2011; Grant et al., 2012c).

While most studies report that GD in women compared to men is "telescoped," one study involving a large Australian twin cohort of over 4,600 individuals found no evidence of this effect (Slutske et al., 2015). In fact, this study showed that men initiated gambling at an earlier age and progressed more rapidly to a GD diagnosis than did women. It is important to consider that these findings were based on "moderately reliable" retrospective reports and secondary analyses of a sample that did not require an elaborate twin study design. Further, the results of this study may not generalize to gamblers in countries outside of Australia.

The discrepancy between the Slutske et al. (2015) telescoping finding and previous studies may be explained by several possible confounds regarding the nature of the samples. First, the age

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of gambling onset varied, where Slutske and colleagues reported the average age of onset to be 17–18 years for both men and women while other studies reported the average ages of onset to be 20–22 years for men and 30–34 years for women. Second, the racial and regional compositions of the samples varied between the Slutske et al. study (Australian, Northern European/Caucasian) and the other studies (North and South American, including all ethnicities). Third, the Slutske et al. study used a community-based as opposed to a treatment-based sample, suggesting that gender-related differences in GD, such as telescoping, may not hold in non-clinical populations. Future studies should investigate these and other possibilities.

POSSIBLE EXPLANATIONS FOR TELESCOPING

Gambling Type

Differences in performed forms of gambling by women compared to men, relating to non-strategic vs. strategic forms (Potenza et al., 2006; Grant et al., 2012b), may partially explain the telescoping effect (Potenza et al., 2001; Tavares et al., 2003). It has been hypothesized that the non-strategic forms of gambling (like slot machines) preferred and performed by women may be more addictive because the time between placing the bet and the outcome is often shorter than some other forms of gambling (Potenza et al., 2001; Tavares et al., 2003; Dowling et al., 2005). This faster display of results may in part explain why some individuals continue gambling as they may feel that they are just a short amount of time away from winning (Dowling et al., 2005). However, this point has been debated (Nower and Blaszczynski, 2010). Specific preference for forms of gambling such as electronic bingo has been related to the telescoping effect (Tavares et al., 2003); however, when type of gambling was considered in models, the telescoping effect still remained (Grant et al., 2012c), suggesting the type of gambling may not account substantially for the telescoping effect.

Co-occurring Disorders

Links between psychopathology and problem-gambling severity appear stronger in women than in men for major depression and stronger in men than in women for alcohol dependence (Lesieur et al., 1986; Welte et al., 2001; Petry et al., 2005; Blanco et al., 2006; Desai and Potenza, 2008). Women compared to men are more likely to seek treatment for GD, which may in part relate to co-occurring psychiatric disorders, particularly depression and anxiety disorders (Potenza et al., 2001; Martins et al., 2004; Desai and Potenza, 2008; Husky et al., 2015). Co-occurring anxiety, depression, and alcohol dependence with GD may exacerbate gambling-related symptoms across both genders (Parhami et al., 2014; Quigley et al., 2015). However, some studies have found that co-occurring disorders relating to depression and anxiety in women and alcohol dependence in men did not explain gambling progression (Tavares et al., 2003; Odlaug et al., 2011; Grant et al., 2012c). Among recreational gamblers, moderate/high alcohol consumption was associated with heavier gambling in men than in women (Desai et al., 2006). In adolescence, gambling behavior is associated with elevated rates of alcohol use in both boys and girl and depression/dysphoria in only girls (Desai et al., 2005). Negative mood states and depression may increase gambling-related behaviors, particularly in women (Tschibelu and Elman, 2010), consistent with negative reinforcement theories in substance-use disorders. Thus, additional research is needed to determine whether and how co-occurring psychiatric disorders may relate to telescoping.

Biological Differences

With respect to genetics, most genetic studies of GD have focused on candidate genes, such as those coding for dopamine receptors and the dopamine transporter; however, these have yielded conflicting results and have under-represented women. One candidate gene study investigating the catechol-O-methyltransferase gene (*COMT*), a gene that codes for an enzyme regulating dopamine in the prefrontal cortex and has a commonly occurring allelic variation (Val158Met) linked to enzymatic function, found that individuals with Met/Met genotypes were twice as likely to be at-least-at-risk gamblers than Val carriers; no gender-related differences were observed (Guillot et al., 2015). Similarly, Met/Met individuals performed worse on decision-making/cognitive impulsivity tasks than Val carriers (Malloy-Diniz et al., 2013).

Using the all-male United States Vietnam Era Twin Registry, percentages of lifetime GD diagnosis were higher in monozygotic (23%) as compared to dizygotic (10%) co-twins (Eisen et al., 1998). Using the Australian Twin Registry, it has been estimated that genetic risk factors account for approximately half of the variability in GD etiology in both men and women (Slutske et al., 2010). Further, the association between GD and alcohol-use disorder has been linked in part to overlapping genetic risk, with men showing a higher correlation between the two disorders than woman when using dimensional (but not categorical) measures (Slutske et al., 2013). A recent study also found that a polygenic risk score for alcohol dependence was associated with GD (Lang et al., 2016). More research is needed to identify gender-related genetic and environmental factors linked to GD susceptibility and progression, particularly as environmental factors appear more closely linked to age of gambling onset in women as compared with men (Richmond-Rakerd et al., 2014).

In relation to neurocognitive measures, male gamblers tend to score higher on risk-taking measures than do female gamblers (Johansson et al., 2009); however, no gender-related differences were found on measures of impulsivity (Grant et al., 2012a). A few neuroimaging studies have begun to investigate the neural mechanisms of GD with respect to craving-related brain regions such as the medial prefrontal and cingulate cortices (Kober et al., 2016). In this study, women with GD showed increased dorsomedial prefrontal, posterior insula, and caudate activation when viewing gambling-related videos, compared to men with GD. The extent to which such differences may relate to telescoping warrants investigation.

Sociocultural Differences

Women may have a later age of GD onset because they may have less exposure to gambling opportunities. Social norms historically have more strongly opposed gambling

in women as compared to men (Potenza et al., 2001); however, this may be changing over time. It has been argued that women experience sociocultural pressures to seek treatment despite gender-related similarities in treatment severity, which may influence observations of telescoping reported in alcoholism (Piazza et al., 1989). Sociocultural differences between gender groups require further investigation to investigate how they relate to disease development and progression.

IMPACT ON PREVENTION AND TREATMENT

While there is currently no evidence for gender-related differences in treatment effectiveness, the authors would like to recommend a few guidelines for more effective prevention and treatment strategies with respect to telescoping considerations. First, because women may progress to GD faster than men and boys tend to exhibit GD more so than girls, earlier interventions for both genders are advised. Second, gambling may be triggered in gender-related fashions—mood states for women and sensory stimuli for men. Women may more likely be triggered by depressive symptoms that are unrelated to the gambling itself, while men may more likely be triggered by gambling-related advertisements, billboards etc. (Grant and Kim, 2002; Martins et al., 2004). Thus, prior to or concurrent with GD treatment, women may benefit from assessment and treatment of depressive symptoms (e.g., through pharmacological approaches) while men may benefit from cognitive-behavioral therapy or other approaches to dampen responses to sensory stimuli, although this possibility is currently speculative. Additionally, policy approaches that regulate gambling advertisements may be particularly important for men. Third, because co-occurrence with alcohol dependence is higher in men than in women, men may benefit from treatment of alcohol-use disorders prior to or concurrent with GD treatment. While best practices may suggest concurrent treatment for co-occurring psychiatric disorders, more research is needed to determine whether sequential vs. concurrent treatments are optimal for co-occurring disorders in association with GD and the extent to which telescoping or other gender-related processes may inform such treatments. Fourth, stress and post-traumatic regulation in women might be helpful as a preventive measure before treatment, particularly for women given the particularly strong links between trauma and gambling problems in women and female-predominant tendencies to gamble as an escape from negative emotions (Getty et al., 2000; Petry and Steinberg, 2005; Dion et al., 2010). Fifth, in treatment-seeking gamblers, females more typically report abstinence, while males often report moderation as their end goals (Kim et al., 2016). The extent to which such differences may relate to telescoping warrants additional study. We suggest that treatment options may be improved if gender-related factors such as telescoping were more closely considered.

While some studies suggest that females may be an at-risk gambling group given more rapid progression of GD, research into telescoping and its etiology are at early stages. Importantly, understanding disease progression and gender-related differences matters if we are going to advance effectively intervention strategies. The relative deficiency of knowledge of gender-related differences in gambling behaviors and the health impacts of gambling could be addressed if future studies focused on early signs of gender-related differences, possible effects of different forms of gambling, problem-gambling severity, psychiatric comorbidity, and biological factors on the progression to disease in women and men. Performing gender-related analyses on sample populations that vary socio-demographically and clinically may promote a better understanding that may be translatable into improved prevention, treatment and policy efforts. Considering important aspects relating to environmental, individual, and contextual factors should facilitate these efforts for both females and males.

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YZ wrote the first draft of the manuscript and worked with all other authors, KC, CM, and MP on subsequent drafts. MP revised the manuscript critically for important intellectual content. All authors have approved this manuscript.

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Development and Psychometric Evaluation of the Brief Adolescent Gambling Screen (BAGS)

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The purpose of this study was to develop and evaluate the initial reliability, validity and classification accuracy of a new brief screen for adolescent problem gambling. The three-item Brief Adolescent Gambling Screen (BAGS) was derived from the nine-item Gambling Problem Severity Subscale (GPSS) of the Canadian Adolescent Gambling Inventory (CAGI) using a secondary analysis of existing CAGI data. The sample of 105 adolescents included 49 females and 56 males from Canada who completed the CAGI, a self-administered measure of DSM-IV diagnostic criteria for Pathological Gambling, and a clinician-administered diagnostic interview including the DSM-IV diagnostic criteria for Pathological Gambling (both of which were adapted to yield DSM-5 Gambling Disorder diagnosis). A stepwise multivariate discriminant function analysis selected three GPSS items as the best predictors of a diagnosis of Gambling Disorder. The BAGS demonstrated satisfactory estimates of reliability, validity and classification accuracy and was equivalent to the nine-item GPSS of the CAGI and the BAGS was more accurate than the SOGS-RA. The BAGS estimates of classification accuracy include *hit rate* = 0.95, *sensitivity* = 0.88, *specificity* = 0.98, *false positive rate* = 0.02, and *false negative rate* = 0.12. Since these classification estimates are preliminary, derived from a relatively small sample size, and based upon the same sample from which the items were selected, it will be important to cross-validate the BAGS with larger and more diverse samples. The BAGS should be evaluated for use as a screening tool in both clinical and school settings as well as epidemiological surveys.

Keywords: adolescent problem gambling, youth problem gambling, brief screen, classification accuracy, psychometric evaluation of brief screen

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INTRODUCTION

A number of brief screens have been developed for adult problem gambling, some as brief as one or two questions, but there are no brief screens for adolescent problem gambling (Stinchfield, 2010, 2014). There are four main assessment tools for adolescent problem gambling and they are the South Oaks Gambling Scale—Revised for Adolescents (SOGS-RA) (Winters et al., 1993, 1995); DSM-IV revised for Juveniles or DSM-IV-J (Fisher, 1992, 2000); Massachusetts Gambling Screen (MAGS) (Shaffer et al., 1994); and the Canadian Adolescent Gambling Inventory (CAGI) (Tremblay et al., 2010). These four adolescent problem gambling assessment tools range in number of items from seven items on the MAGS, 12 items on the DSM-IV-J and SOGS-RA, and 44

items on the CAGI, although nine of those 44 items are used to identify problem gambling. While seven items may be considered "brief" there are some settings and screening purposes where a smaller number of items is required, such as student surveys that attempt to screen for a large number of risky behaviors with the fewest number of items, such as the Minnesota Student Survey (Stinchfield, 2011). Therefore, there is a need for a brief screen for adolescent problem gambling.

How should a brief screen for adolescent problem gambling be developed? Stinchfield (2010) reported that most adolescent problem gambling measurement tools are scales originally developed for adults and then later adapted for adolescents, such as the SOGS-RA and DSM-IV-J. Because these scales were originally developed for adults, their content may not be applicable to adolescents, and therefore may not be appropriate as a source of items for adolescents. In contrast, the CAGI was developed from the outset specifically for adolescents (Wiebe et al., 2005, 2008). A consortium of Canadian provincial funding organizations directed a four-member research team to develop a measure of adolescent problem gambling under the supervision of the Canadian Centre on Substance Abuse (CCSA). The four-member research team included Dr. Jamie Wiebe of Ontario, Dr. Harold Wynne of Alberta, Dr. Joel Tremblay of Quebec, and Dr. Randy Stinchfield of Minnesota. Adolescents were included in the development of the CAGI and participated in focus groups to review and edit the content of the CAGI to make sure it was appropriate and relevant for adolescents. The timeframe of the CAGI inquires about gambling behaviors in the past 3 months to match an adolescent's focus on recent activities rather than the distant past, particularly since adolescence is a time of rapid changes and development. An adolescent's behavior of a year ago may not reflect their current behavior at all. The CAGI measures how often and how much time adolescents play 19 types of gambling; and two items inquire about the amount of money (or items of value) lost gambling. The CAGI purports to measure four gambling-related domains of loss of control, and social, psychological, and financial consequences. A fifth scale, Gambling Problem Severity Scale (GPSS), purports to identify problem gambling. It should be noted that many of the CAGI items did not originate with the CAGI, but rather were borrowed from other instruments and found to be reliable, valid, and accurate for the new CAGI scales. The CAGI was found to yield satisfactory estimates of reliability, validity and classification accuracy (Tremblay et al., 2010).

Because the CAGI was the only assessment tool developed specifically for adolescents and has items written by and for adolescents, and because it has demonstrated satisfactory psychometric properties, the CAGI was chosen as the source of items for the development of a new brief screen. Furthermore, the GPSS of the CAGI was developed from a large pool of diagnostic items that was narrowed down to a set of nine items that demonstrated classification accuracy for Gambling Disorder among adolescents. These nine items served as the item pool from which a brief screen for adolescent problem gambling was developed. The purpose of this study is to develop and evaluate the initial reliability, validity, and classification accuracy of a new brief screen for adolescent problem gambling.

METHOD

Participants

Data were used from 105 Canadian adolescents who were recruited for the CAGI development study in 2008 and 2009 from schools in Manitoba and Quebec ($n = 66$; males = 32; females = 34) and seven clinics in Quebec ($n = 39$; males = 24; females = 15). The sample ranged in age from 12 to 19 years; 84% were White; and 83% were from Quebec and spoke French and 17% were from Manitoba and spoke English. The goal of this recruitment from both school and clinical settings was to find a sufficient number of adolescents with gambling problems for the development of an adolescent problem gambling instrument. This study used existing data from the 2008 to 2009 CAGI development study with no individual identifiers and does not involve living human subjects and therefore is exempt from ethics review. The original CAGI development research from which this data was obtained had ethics approval: Ethical committee for Addiction Specialized Treatment Centers in Quebec, certificate number: CERT/2005-040. For more details about this sample, please see Tremblay et al. (2010) and Wiebe et al. (2008).

Instruments

The CAGI is a 44-item paper-and-pencil questionnaire that can be administered in 20 min. The CAGI goes beyond a simple single scale to measure gambling by measuring multiple domains of gambling problem severity. The CAGI has 19 items that measure gambling frequency using six-point response options and time spent gambling in a typical week on 19 forms of gambling and two items to measure money and items of value lost gambling. One of the 19 forms of gambling is a fake game called "Blotzito" to measure invalid and inattentive responding, response distortion and exaggeration or faking bad. The second half of the CAGI measures five problem gambling-related domains: (a) Gambling Problem Severity Scale (GPSS; 9 items); (b) psychological consequences (6 items); (c) social consequences (5 items); (d) financial consequences (6 items); and (e) loss of control (4 items). The intent of the developers of the CAGI was to measure the continuum and the complexity of gambling behavior, rather than a dichotomy of either presence or absence of problem gambling as is found in most existing adolescent and adult instruments. The developers also wanted to produce an instrument that would be useful for epidemiological studies as well as for clinical and school settings. Early estimates of reliability, validity, and classification accuracy are satisfactory including reliability coefficient *alphas* ranging from 0.83 to 0.90, temporal stability coefficients ranging from 0.77 to 0.90; convergent validity coefficients ranging from $r = 0.14$ to 0.67; and for the GPSS *sensitivity* = 0.93 and *specificity* = 0.93 (Tremblay et al., 2010).

The reference standard against which the new brief screen was tested was DSM-5 diagnostic criteria for Gambling Disorder (GD). DSM-5 GD was measured with Stinchfield's DSM-IV diagnostic criteria for Pathological Gambling, a self-administered paper-and-pencil questionnaire (as well as clinician-administered interview) which is part of the Gambling Treatment Outcome Monitoring System (GAMTOMS;

Stinchfield et al., 2007) and has been revised for DSM-5 (Stinchfield et al., 2016). These same 10 diagnostic items were included in a clinician-administered diagnostic interview to obtain a DSM-5 diagnosis of GD. The reference standard was a combination of the adolescent's self-report on a paper-and-pencil questionnaire to measure DSM-5 diagnostic criteria for GD and the clinician-administered diagnostic interview for GD. Both the adolescent and the clinician had to have GD present for the case to be in the GD group.

Stinchfield's measure of DSM-IV diagnostic criteria for Pathological Gambling includes 10 items, one item for each criterion, paraphrased from the 10 DSM-IV diagnostic criteria for Pathological Gambling (American Psychiatric Association, 1994). The DSM-IV measure was adapted to measure DSM-5 diagnostic criteria for Gambling Disorder (American Psychiatric Association, 2013) for this study by deleting the illegals acts criterion, resulting in nine criteria, and using a cut score of four to diagnose GD, rather than five as in DSM-IV. See Appendix A for a copy of Stinchfield's measure of DSM-IV diagnostic criteria of Pathological Gambling and rules for adaptation to DSM-5. This measure has demonstrated satisfactory reliability with internal consistency estimates of Cronbach's *alpha* ranging from 0.87 to 0.98 for a combined community and gambling treatment sample (Stinchfield et al., 2016), and temporal stability as measured by 1-week test-retest was *Intraclass Correlation* = 0.71 (Stinchfield et al., 2016). In terms of convergent validity, the DSM-5 GD scale was correlated with the SOGS $r = 0.97$ (Stinchfield et al., 2016). In terms of classification accuracy, using the DSM-5 cut score of four to indicate a diagnosis of GD (American Psychiatric Association, 2013), and using a reference standard of group membership (clinical vs. community), this scale yielded a *hit rate* range from 0.90 to 0.99, *sensitivity* range from 0.88 to 0.98, and *specificity* range from 0.83 to 0.99, all of which are satisfactory (Stinchfield et al., 2016).

The South Oaks Gambling Scale—Revised for Adolescents (SOGS-RA) is an adaptation of the South Oaks Gambling Scale (SOGS; Lesieur and Blume, 1987) for adolescents (Winters et al., 1993, 1995). The SOGS-RA purports to measure signs and symptoms of problem gambling and negative consequences over the past year. The SOGS-RA consists of 12 items with yes/no response options. A score of four or more indicates problem gambling. The SOG-RA has demonstrated satisfactory evidence of reliability, validity and classification accuracy (Stinchfield, 2010).

Procedures

As stated earlier, this study relied on a secondary analysis of existing data from a sample of 105 adolescents who participated in the 2008–2009 CAGI development study (Tremblay et al., 2010). The sample was recruited from schools in Manitoba and Quebec; and seven clinics in Quebec. In Manitoba, participation required student and parental consent. In Quebec, parental consent was required for students 13 years of age or younger. Teachers read a consent form aloud in their classroom and the students were given a consent form to take home for their parents/guardians to read and sign. Students were informed that their answers would be kept confidential and that their names would not be used on the questionnaire. After signed consent forms were obtained, the CAGI was administered via paper-and-pencil questionnaire. Following in-class administration of the CAGI and upon student consent of follow-up contact, researchers invited 200 of the highest frequency gamblers to participate in a follow-up assessment that included administration of Stinchfield's measure of DSM-IV diagnostic criteria for Pathological Gambling and a clinical interview. In total, 109 students participated in the clinical interview, however, 43 interviews were not retained for analysis because the student reported gambling on a fictitious gambling activity named "Blotzito" ($n = 5$), missing data from follow-up assessment ($n = 1$), or too long a delay (>4 weeks) between class administration of CAGI and the clinical interview ($n = 37$). Sixty-six valid student interviews were retained.

The clinical setting included clinics for youth with problem behavior and substance abuse. New clients were screened during the admission process using the SOGS-RA. Clients scoring three or more were informed of the study and, if interested, signed a form giving a research team member authorization to contact them. Once the consent form was signed, the participant was administered the CAGI, Stinchfield's measure of DSM-IV diagnostic criteria for Pathological Gambling, and a clinical interview. The clinical interview included a copy of the DSM-IV diagnostic criteria for Pathological Gambling and interviewers were asked to endorse each criterion they judged to be present for each participant. Participants from the school settings were not administered the SOGS-RA. The interviewers were five clinicians, including four females and one male, two had a master's degree in psychology and two had a baccalaureate degree in social work and one was a doctoral student. All of them, except the doctoral student, were clinicians specialized in the treatment of problem gambling and working in a specialized addiction treatment center. Their years of experience ranged from 7 to 20 years, except for the doctoral student who had 1 year of experience from her clinical work as a doctoral student. The interviewers were trained in problem gambling assessment. They were hired to conduct these interviews. For more details of the procedures, please see Tremblay et al. (2010).

Data Analyses for Screen Development and Psychometric Evaluation

Screen development included three procedures. First, all nine GPSS items were entered into a stepwise multivariate Discriminant Function Analysis (DFA) with DSM-5 diagnosis of GD as the dependent variable. The goal was to identify the best items for classification of GD diagnosis.

Second, the smaller set of items identified by the DFA were summed and a cut score was determined by examining the frequency distributions of the new screen in the GD and No GD groups, and computing classification accuracy indices for different cut scores. Classification accuracy was assessed with standard accuracy indices including hit rate (diagnostic efficiency), sensitivity, and specificity (Fleiss, 1981; Baldessarini et al., 1983; Friedman and Cacciola, 1998) with cut score selection based on maximizing classification accuracy and balancing false

positive and false negative errors. Since a brief screen would likely be used in various settings and for different purposes it was decided to balance false positive and false negative errors, rather than give preference to one type of diagnostic error over another in the cut score selection.

Third, psychometric evaluation included computations of reliability, validity and classification accuracy of the new screen (Nunnally, 1978; Allen and Yen, 1979; American Educational Research Association, American Psychological Association, National Council on Measurement in Education, 1999). Reliability was examined by computing both Cronbach's (1951) coefficient *alpha;* and McDonald's coefficient *omega* (McDonald, 1985; Gadermann et al., 2012) which is recommended for estimating reliability of items with ordinal response options. Cronbach's *alpha* and McDonald's *omega* are interpreted on a scale from 0 to 1. The higher the *alpha or omega*, the better the reliability of the scale. Coefficient *alpha* is effected by the number of items in a scale, the larger the number of items the higher the internal consistency, such that a coefficient *alpha* on a brief screen will be attenuated by the few number of items. As a criterion, Nunnally (1978) suggests that scales have an *alpha* of 0.70 or greater to be considered as having a minimal level of internal consistency for research purposes.

Validity was examined by measures of convergent validity. Convergent validity refers to how well a scale correlates or converges with an alternate measure of the same construct. Convergent validity was examined by measuring the relationship between the screen and the SOGS-RA. The SOGS-RA is a measure of problem gambling adapted for adolescents, and therefore the new screen should be related to the sum of the 12 SOGS-RA items. To demonstrate evidence of convergent validity, the screen should obtain moderate to high correlations ($r > 0.30$) with other measures of the same construct (Cichetti, 1994).

Classification accuracy was measured by computing standard diagnostic statistics of hit rate (diagnostic efficiency), sensitivity, specificity, false negative rate, and false positive rate (Fleiss, 1981; Baldessarini et al., 1983; Friedman and Cacciola, 1998). In order to demonstrate satisfactory classification accuracy, the hit rate (diagnostic efficiency), sensitivity and specificity must all be 0.80 or greater (Cichetti, 1994; Glascoe, 2005; DiStefano and Morgan, 2011).

To compute the DFA and the classification accuracy analyses a reference or "gold" standard is used against which to compare the test. There is no consensus among investigators about what to use for a reference standard for diagnosing GD, so investigators have used standardized diagnostic interviews or group membership (general population vs. a GD treatment sample). In this study, to create a reference standard, the DSM-5 diagnosis of GD was determined by the combination of the adolescent's self-report on a paper-and-pencil questionnaire to measure DSM-5 diagnostic criteria for GD and the clinician administered diagnostic interview of DSM-5 diagnostic criteria for GD. Both the adolescent and the clinician had to have GD present for the case to be in the GD group. The inter-rater agreement between adolescent self-administered questionnaire and clinician-administered diagnostic interview for DSM-5 diagnosis of GD was *kappa* = 0.76, which is excellent agreement (Cohen, 1960; Fleiss, 1981). A kappa value > 0.75 generally indicates "excellent" agreement, a value between 0.40 and 0.75 indicates "satisfactory" agreement, and a value < 0.40 indicates "poor" agreement (Fleiss et al., 2003).

RESULTS

Selection of Items for the Brief Adolescent Gambling Screen (BAGS)

The nine items of the CAGI GPSS were entered into a stepwise multivariate DFA with DSM-5 diagnosis of GD as the dependent variable. The stepwise multivariate DFA yielded three items as the best predictors of membership in the GD group and maximized classification accuracy. **Table 1** shows the best or strongest predictor GPSS items selected from the DFA along with the unstandardized canonical discriminant function coefficient for each item. Items are ordered by magnitude of the unstandardized canonical discriminant function coefficient which is the weight of the item in an equation to classify each adolescent into the GD or No GD group. Item weights, along with a constant, are used in an equation to compute a score for each case. The score for each case is then compared to the group centroid for each of the two groups and whichever centroid the case score is closest to, is the group assignment for that case.

Cut Score Selection and Classification Accuracy of the BAGS

The BAGS could be scored using the DFA equation including the item weights, however, this adds a layer of complication for screen users and it is likely not much more accurate than using a summed raw score derived by summing the response option from each item (0, 1, 2, or 3). Furthermore, item weights can vary by population and therefore the item weights from this sample may be unique and may not generalize to a different sample.

The BAGS has three items with four-point response options that are coded as 0–3, for a total score range of 0–9. **Table 2** shows a cross-tabulation of the frequency distribution of BAGS scores from 0 to 9 for the two groups by Gambling Disorder

TABLE 1 | Brief Adolescent Gambling Screen (BAGS): Three best CAGI GPSS items and Unstandardized Canonical Discriminant Function Coefficients (UCDFC).

BAGS item (CAGI gambling problem severity scale item)	UCDFC
BAGS #1 (CAGI #26). Skipped hanging out with friends who do not gamble/bet	1.265
BAGS #2 (CAGI #40). Felt that you might have a problem with gambling/betting	0.868
BAGS #3 (CAGI #37). Hidden your gambling/betting from your parents, other family members or teachers	0.483
Discriminant Function equation = (Constant = −1.296) + (CAGI #26 * 1.265) + (CAGI #40 * 0.868) + (CAGI #37 * 0.483). Group Centroid for No Gambling Disorder = −0.834; Group Centroid for Gambling Disorder = 2.814	

Items are rank ordered by magnitude of the Unstandardized Canonical Discriminant Function Coefficient (UCDFC).

TABLE 2 | Probability of DSM-5 Gambling Disorder (GD) for each BAGS Score from 0 to 9.

BAGS score	DSM-5 GD Status		Probability of GD
	GD	No GD	
0	0	57	0/57 = 0%
1	0	7	0/7 = 0%
2	2	7	2/9 = 22%
3	1	8	1/9 = 11%
4	5	1	5/6 = 83%
5	7	1	7/8 = 88%
6	4	0	4/4 = 100%
7	4	0	4/4 = 100%
8	1	0	1/1 = 100%
9	0	0	0/0 = 0%

TABLE 3 | Crosstabulation of the BAGS and DSM-5 Gambling Disorder.

BAGS cut score	DSM-5 GD		Row totals
	Gambling disorder	No gambling disorder	
4+	21	2	23
<4	3	79	82
Column Totals	24	81	105

Base Rate = 24/105 = 0.23
Hit Rate = (21 + 79)/105 = 0.95
Sensitivity = 21/24 = 0.88
Specificity = 79/81 = 0.98
False Positive Rate = 2/81 = 0.02
False Negative Rate = 3/24 = 0.12

TABLE 4 | Crosstabulation of the CAGI GPSS and DSM-5 Gambling Disorder.

CAGI GPSS cut score	DSM-5 GD		Row totals
	Gambling disorder	No gambling disorder	
6+	24	12	36
<6	0	69	69
Column Totals	24	81	105

Base Rate = 24/105 = 0.23
Hit Rate = (24 + 69)/105 = 0.89
Sensitivity = 24/24 = 1.00
Specificity = 69/81 = 0.85
False Positive Rate = 12/81 = 0.15
False Negative Rate = 0/24 = 0.00

and No Gambling Disorder, along with the probability. There was an increasing probability of having a GD with increasing BAGS score. A score of 0, 1, 2, or 3 resulted in almost no chance of having a GD. A score of four or greater indicated a very high likelihood of GD, and scores of 6 or greater indicated certainty of having GD. Therefore, a cut score of four maximized classification accuracy and balanced false positive and false negative classification errors. A cross-tabulation of the BAGS cut score of four and GD is shown in **Table 3**. The BAGS yielded satisfactory evidence of classification accuracy with hit rate, sensitivity and specificity of 0.95, 0.88, and 0.98, respectively. It should be noted that the same sample of adolescents was used to select the items and compute classification accuracy and this likely inflates classification accuracy.

For purposes of comparison, the cross-tabulation for the nine-item CAGI GPSS and GD is shown in **Table 4**, along with classification accuracy indices. The CAGI GPSS yielded satisfactory classification accuracy with hit rate, sensitivity and specificity of 0.89, 1.00, and 0.85, respectively. The BAGS had a higher hit rate and specificity, but lower sensitivity than the CAGI GPSS. The CAGI GPSS had no false negative cases, but 12 false positive cases due to its design to minimize false negative errors, the more serious classification error in clinical settings. The BAGS balanced classification errors with three false negative errors and two false positive errors.

For purposes of comparison, the cross-tabulation for the SOGS-RA (using a standard cut score of four) and GD for the 39 adolescents who had both the SOGS-RA and GD, is shown in **Table 5** and the cross-tabulation of the BAGS for the same 39 adolescents is shown in **Table 6**. The SOGS-RA did not yield satisfactory classification accuracy with hit rate, sensitivity and specificity of 0.64, 0.87, and 0.31, respectively. Only sensitivity was above the minimum criterion of 0.80 for satisfactory classification. The BAGS had a higher hit rate, sensitivity and specificity, than the SOGS-RA and all of the BAGS classification accuracy coefficients were above the minimum criterion of 0.80.

Reliability

Reliability of the BAGS as measured by Cronbach's (1951) coefficient *alpha* was 0.72; and as measured by McDonald's coefficient *omega* was 0.79.

Validity

Convergent validity coefficient for BAGS and SOGS-RA, $r = 0.67$.

DISCUSSION

The purpose of this study was to develop and evaluate the psychometric properties of a new brief screen to measure problem gambling among adolescents. This new brief screen was developed from the CAGI, an assessment tool that was specifically designed for adolescents, and therefore this is an advantage over using questions developed for adults and then later adapted for adolescents, as was done with the SOGS-RA. The three items were identified from a statistical procedure, stepwise multivariate discriminant function analysis, that is used

TABLE 5 | Crosstabulation of the SOGS-RA and DSM-5 Gambling Disorder in subsample with SOGS-RA ($n = 39$).

SOGS-RA cut score	DSM-5 GD		Row totals
	Gambling disorder	No gambling disorder	
4+	20	11	31
<4	3	5	8
Column Totals	23	16	39

Base Rate = 23/39 = 0.59
Hit Rate = (20 + 5)/39 = 0.64
Sensitivity = 20/23 = 0.87
Specificity = 5/16 = 0.31
False Positive Rate = 11/16 = 0.69
False Negative Rate = 3/23 = 0.13

TABLE 6 | Crosstabulation of the BAGS and DSM-5 Gambling Disorder in subsample with SOGS-RA ($n = 39$).

BAGS cut score	DSM-5 GD		Row totals
	Gambling disorder	No gambling disorder	
4+	21	1	22
<4	2	15	17
Column Totals	23	16	39

Base Rate = 23/39 = 0.59
Hit Rate = (21 + 15)/39 = 0.92
Sensitivity = 21/23 = 0.91
Specificity = 15/16 = 0.94
False Positive Rate = 1/16 = 0.06
False Negative Rate = 2/23 = 0.09

to select the best items from a pool of items in order to accurately classify cases into two groups. The statistical procedure selected three of the nine CAGI GPSS items that were the best predictors of group membership (GD vs. No GD). These three items make up the new Brief Adolescent Gambling Screen (BAGS) and this new screen is in the public domain, that is, free of charge to use.

Next, the psychometric properties, reliability, validity, and classification accuracy, of the new screen were measured and compared to *a priori* criterion levels for each property and psychometric standards for behavioral instruments (Nunnally, 1978; Allen and Yen, 1979; American Educational Research Association, American Psychological Association, National Council on Measurement in Education, 1999). The reliability of the BAGS was measured with Cronbach's *alpha* and was 0.72, which is just above the minimum level of reliability, *alpha* > 0.70, for research purposes (Nunnally, 1978). The number of items in a scale effects the magnitude of Cronbach's *alpha* such that fewer items attenuate *alpha* and this must be considered in the context of a three-item brief screen. The reliability of the BAGS as measured by McDonald's *omega* was 0.79 and this initial estimate of reliability is satisfactory.

The convergent validity of the BAGS was measured by correlation with the adolescent self-administered SOGS-RA ($r = 0.67$). This validity coefficient was above the minimum of $r > 0.30$ (Cichetti, 1994) and shows preliminary evidence for the validity of the BAGS.

The BAGS has a score range of 0–9 and a cut score of four maximized classification accuracy and balanced false positive and false negative errors. The classification accuracy of the BAGS was measured by computing standard diagnostic statistics of hit rate (diagnostic efficiency), sensitivity, specificity, false negative rate, and false positive rate (Fleiss, 1981; Baldessarini et al., 1983; Friedman and Cacciola, 1998). The BAGS yielded satisfactory evidence of classification accuracy with hit rate, sensitivity, and specificity of 0.95, 0.88, and 0.98, respectively, all of which are above the minimum criterion for satisfactory classification accuracy of 0.80 (Cichetti, 1994; Glascoe, 2005; DiStefano and Morgan, 2011). It should be noted that this sample of adolescents was used to select the BAGS items and this procedure likely inflates classification accuracy.

For comparison purposes, the accuracy of the BAGS was compared to that of the CAGI GPSS and SOGS-RA. The BAGS had a higher hit rate and specificity, but lower sensitivity than the CAGI GPSS. The BAGS had higher hit rate, sensitivity, and specificity than the SOGS-RA. The BAGS was equivalent to the CAGI GPSS and more accurate than the SOGS-RA, however, it should be noted that both the CAGI GPSS and the SOGS-RA have cut scores that are designed to minimize false negative errors at the expense of more false positive errors, whereas the BAGS cut score was designed to balance false negative and false positive errors and this likely explains differences in the classification accuracy of the BAGS compared to the CAGI GPSS and SOGS-RA. If the BAGS is used in anonymous adolescent surveys, the cut score of 4+ can be used to obtain a prevalence estimate. However, if the BAGS is to be used to identify adolescents for further assessment and diagnosis, then the cut score may need to be lowered in order to minimize false negative errors. Based on the sample used in this study, a cut score of 2+ would eliminate false negative errors (0/24 = 0), however this lower cut score would also inflate false positive errors (17/81 = 0.21) and that is the tradeoff for no false negative errors.

A note about the source of these three items. Two of these three items, while borrowed from the CAGI for this study, do not originate from the CAGI, but rather were adapted for the CAGI from other sources. The item, "How often have you felt that you might have a problem with gambling/betting?" can be traced to the SOGS (Lesieur and Blume, 1987) and it is also included in the SOGS-RA (Winters et al., 1993) and Canadian Problem Gambling Index (CPGI; Ferris and Wynne, 2001). The item, "How often have you hidden your gambling/betting from your parents, other family members or teachers?" can be found in the SOGS, SOGS-RA, DSM-IV, and DSM-5 diagnostic criteria (American Psychiatric Association, 2013). The item "How often have you skipped hanging out with friends who do not gamble/bet to hang out with friends who do gamble/bet?"

was written by the CAGI development team and was inspired by adolescent substance abuse instruments.

Limitations and Future Research Directions

There are limitations of this study that need to be noted. First, the data are based on adolescent self-report and there is no objective verification of the accuracy of this information. However, efforts were made to enhance the validity of self-report by informing respondents that their answers would be kept confidential and participants were informed that their names would not be used on instruments. Nevertheless, the data are dependent on self-report and further research needs to be conducted on the validity of self-report about gambling behaviors. Second, classification accuracy was computed from the sample used to compute the discriminant function and this maximizes classification accuracy. Therefore, these results need to be cross-validated on other samples and in different settings. Third, the results are based on a relatively small sample of adolescents. Therefore, the BAGS should be cross-validated on larger and more diverse samples of adolescents, including non-white adolescents.

In summary, the BAGS demonstrated satisfactory reliability, validity, and classification accuracy and in this preliminary study, the BAGS yielded equivalent accuracy to the CAGI GPSS and better accuracy than the SOGS-RA. The BAGS can be used in those projects limited to a small number of items to screen for adolescent problem gambling. Different cut scores are recommended for different purposes. For anonymous surveys where the goal is a sample or population prevalence rate, a cut score of four or more is recommended to balance false negative and false positive errors. For clinical settings or for purposes of identifying individuals who require further assessment and a diagnostic interview, a cut score of two or more is recommended to minimize false negative errors (which will raise the false positive rate). A sign of a maturing scientific field is that the instruments used to measure the phenomenon of interest become more precise, and it is the intent of this study to improve the screening and assessment of adolescent problem gambling.

AUTHOR CONTRIBUTIONS

RS was the lead author and was involved in all aspects of the literature review, statistical analyses, and reporting of the results. HW, JW, and JT were involved in all aspects of the project and writing and each had an area or two of focus. HW focused on the conceptualization of adolescent problem gambling, JW and JT focused on project management and JT also focused on the statistical analyses. All four authors were involved in the writing and editing of the manuscript.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

APPENDIX A

Stinchfield's measure of DSM-IV diagnostic criteria for Pathological Gambling.
For this adolescent study, a time period of "During the past 3 months" was used to match the CAGI time period.

1. Have there been periods when you spent a lot of time thinking about past gambling experiences, thinking about future gambling ventures, or thinking about ways of getting money with which to gamble?	Yes	*No*
2. Have you needed to gamble with larger amounts of money or with larger bets in order to obtain the same feeling of excitement?	Yes	No
3. Have you tried to cut down or stop your gambling several times in the past and been unsuccessful?	Yes	No
4. Did you feel quite restless or irritable after you tried to cut down or stop gambling?	Yes	No
5. Do you feel that you gamble as a way to run away from personal problems or to relieve uncomfortable emotions, such as nervousness or sadness?	Yes	No
6. After you lose money gambling, do you often return another day to try to win back your losses?	Yes	No
7. Have you lied to family members, friends, or others in order to hide your gambling from them?	Yes	No
8. Have you committed any illegal acts (such as theft, forgery, embezzlement, or fraud) to finance your gambling?	Yes	No
9. Have you almost lost or actually lost a relationship with someone important to you, or a job, or school or career opportunity because of gambling?	Yes	No
10. Have you relied on others to bail you out and pay your gambling debts or to pay your bills when you have financial problems caused by gambling?	Yes	No

Scoring Instructions: For DSM-IV, five or more items endorsed with a "Yes" answer, indicate Pathological Gambling. To adapt for DSM-5: exclude criterion #8; and use cut score of four or more items endorsed with a "Yes" answer, to indicate Gambling Disorder.

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Gender Invariance of the *Gambling Behavior Scale for Adolescents* (GBS-A): An Analysis of Differential Item Functioning Using Item Response Theory

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As there is a lack of evidence attesting the equivalent item functioning across genders for the most employed instruments used to measure pathological gambling in adolescence, the present study was aimed to test the gender invariance of the *Gambling Behavior Scale for Adolescents* (GBS-A), a new measurement tool to assess the severity of Gambling Disorder (GD) in adolescents. The equivalence of the items across genders was assessed by analyzing Differential Item Functioning within an Item Response Theory framework. The GBS-A was administered to 1,723 adolescents, and the graded response model was employed. The results attested the measurement equivalence of the GBS-A when administered to male and female adolescent gamblers. Overall, findings provided evidence that the GBS-A is an effective measurement tool of the severity of GD in male and female adolescents and that the scale was unbiased and able to relieve truly gender differences. As such, the GBS-A can be profitably used in educational interventions and clinical treatments with young people.

Keywords: gambling disorder, adolescents, gender invariance, differential item functioning, item response theory

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INTRODUCTION

International studies found gender differences in gambling problem severity among adolescents, indicating that boys are more likely than girls to report gambling problems (see Splevins et al., 2010; Calado et al., 2017, for reviews). Gender differences have been evidenced with different-aged samples belonging to various cultural contexts and by using different measurement tools (e.g., Delfabbro et al., 2009; Molde et al., 2009; Donati et al., 2013; Gupta et al., 2013). These instruments include the most employed scales used internationally, such as the *South Oaks Gambling Screen-Revised for Adolescents* (SOGS-RA; Winters et al., 1993), the *Diagnostic and Statistical Manual—Fourth Edition* [DSM-IV; American Psychiatric Association (APA), 1994], *Adapted for Juveniles* (DSM-IV-J; Fisher, 1992) and its revised version, the *Multiple-Response Format for Juveniles* (DSM-IV-MR-J; Fisher, 2000), and the *Massachusetts Adolescent Gambling Screen* (MAGS; Shaffer et al., 1994). Across the studies, gender differences have been detected by comparing the prevalence rates for each gambling problem severity category. In detail, classifying adolescent gamblers in non-problem, at-risk, and problem gamblers, boys have been found to be more likely to show at-risk and problem gambling behavior than girls, which have been more likely to be non-problem gamblers.

As the prevalence rates of gambling problem severity categories basically derive from the respondents' endorsement of test items, the question that arises is whether the employed instruments are gender-invariant, i.e., if a randomly selected girl with a specific level of gambling-related problems and a randomly selected boy with the same level of gambling-related problems have the same chance to endorse the items of a scale measuring problem gambling. Indeed, if this is not the case, a test is not metrically invariant, i.e., it does not measure the same construct in the same way in different groups because the responses to the items (or part of them) are related to group membership and not to the measured construct. As a consequence, the comparison of test scores between different groups of individuals has to be not considered valid (Waiyavutti et al., 2011).

Referring to the above mentioned measurement tools employed in adolescent gambling research, there is a lack of studies investigating their measurement invariance. Only Molde et al. (2009), using Item Response Theory (IRT), tested the Differential Item Functioning (DIF) across genders of the MAGS. The analysis of DIF is central to the investigation of the measurement equivalence of a scale at the item level because it allows to ascertain whether the response to an item is related to group membership and not to the measured construct (i.e., if a measure is biased because people, which belong to *different* group but hold the *same* characteristics with respect to the measured construct, answer differently). Molde et al. (2009) showed that all the items of the scale functioned differently in male and female respondents. As such, the gender differences observed employing this scale might be misleading because it is not possible to ascertain if they reflect actual differences in problem gambling among male and female adolescents or if they reflect differences related to group membership.

Following this premise, testing gender measurement invariance of the tools employed to assess pathological gambling in adolescents should be considered a prerequisite to investigate gender differences. Thus, the aim of the present work was to investigate whether the *Gambling Behavior Scale for Adolescents* (GBS-A; Primi et al., 2015) was gender-invariant in measuring pathological gambling severity in male and female gamblers. Specifically, to offer evidence that the GBS-A was gender invariant, we aimed to test its equivalence across genders by exploring DIF within the IRT framework, which allows us to assess whether the test items measure problem gambling *fairly* in boys and girls.

In respect of the above mentioned scales, which were developed before the fifth *Diagnostic and Statistical Manual of Mental Disorders* [DSM-5; American Psychiatric Association (APA), 2013], the GBS-A is a scale for adolescents that measures gambling habits and Gambling Disorder (GD), as conceptualized in the last edition of the DSM, which includes the specifications that different and progressive levels (mild, moderate, severe) of GD severity can occur and that GD may apply also to adolescents and young people. Additionally, the scale was chosen because it was developed taking into account the largely shared indication that different aspects of problem gambling are not equivalent indicators of pathology (e.g., Shaffer et al., 1994; Wiebe et al., 2000; Derevensky and Gupta, 2004; Colasante et al., 2014; Edgren et al., 2016). In particular, to fit with this indication, the scale was developed applying IRT. Indeed, inside the IRT framework, one of the item characteristics is its location, which can be conceptualized as the "severity" of the symptom described by the item. Thus, applying a IRT-based scoring procedure, the GBS-A allows to measure GD taking into account the relative weight (i.e., the severity) of each symptom described by the items of the scale.

Finally, given the large consensus about the fact that boys hold higher levels of GD severity than girls (see Splevins et al., 2010; Calado et al., 2017, for reviews), we aimed to test if the GBS-A was able to confirm this difference in GD between male and female adolescent gamblers. In detail, we wanted to explore the gender differences and similarities in the GBS-A items endorsement, in the total score, and in the derived classification into non-problem gamblers, at-risk gamblers, and disordered gamblers.

METHODS

Participants

Participants were 1,723 (56% males) 11- to 23-year-old students attending middle and secondary schools in suburban and urban school districts in Italy with a mean age of 15.64 years ($SD = 1.79$). The data collection took place in agreement with the schools (the research project was approved by the schools' local ethical committee) and following the requirements of privacy and informed consent requested by Italian law (Legislative Decree DL-196/2003). In detail, written informed assent was provided by students and written informed consent was provided by the parents if the student was a minor. Regarding the ethical standards for research, the study referred to the last version of the Declaration of Helsinki (World Medical Association, 2013).

Measures and Procedure

The GBS-A (Primi et al., 2015) is composed of two sections. The first one consists of unscored items investigating gambling behavior. Specifically, these items assess the frequency (never, sometimes in the year, sometimes in the month, sometimes in the week, daily) of participation during the last year in ten gambling activities (card games, bets on games of personal skill, bets on sports games, bets on horse races, bingo, slot machines, scratch cards, lotteries, online games, and private bets with friends), gambling versatility, the gambling partners (alone, with friends, with boyfriend/girlfriend, with someone of the family), relative gambling frequency with them (never, sometimes, often), and the amount of money spent on gambling.

The second section is composed of nine items, each one developed in order to relieve one of the nine DSM-5 diagnostic criteria of GD among adolescents. An example of item is "*Have you spent in gambling money intended for other purposes?*" All items have a three-response format, i.e., 0 = never, 1 = sometimes, 2 = often. This scale was proved to be unidimensional and the Test Information Function (TIF), which is used to evaluate the precision of the test at different levels of the measured construct, showed that the instrument was highly informative for mid- to high-levels of severity of GD. Validity

measures were provided showing significant relationships with gambling frequency, problem gambling (as measured by the SOGS-RA; Italian version: Colasante et al., 2014), and a large array of risk factors for gambling problems, such as gambling-related cognitive distortions, sensation seeking, superstitious thinking, pressure to conform to peers, and social independence from peers.

Based on the responses to this section, for each respondent is possible to derive a IRT-based score, which basically consists in a sum of the frequency by which each of the items endorsed have been experienced, weighted on the specific severity and discrimination parameters characterizing these items. Following this IRT-based scoring procedure, respondents can be classified into non-problem gamblers, at-risk gamblers, and disordered gamblers (Primi et al., 2015).

The GBS-A was administered within the classrooms and during school time by professionally trained researchers. The students were provided with a brief introduction to the study, and with some instructions. Each participant worked individually. Answers were collected in a paper-and-pencil format, and data collection was completed in about 20 min.

Data Analysis

Preliminarily, we measured gambling frequency, gambling versatility, gambling partners, and the amount of money spent on gambling by gender. Then, considering the second section, analyses of DIF across genders were performed by applying the IRT Likelihood Ratio test approach implemented in IRTPRO (Cai et al., 2011) and, according to the response format, Samejima's (1969) graded response model (GRM), one of the most used models for graded polytomous data, was chosen.

Prior to conduct the DIF gender analyses, we looked at the assumptions of the unidimensionality and the item fit under the GRM in each gender group. The unidimensionality of the scale was evaluated by the presence of local dependence (LD) and a χ^2 LD statistic was used. Values equal to 10 or greater indicate an excess in covariation among item responses that is not explained by the unidimensional model. Then, the item fit under the GRM was tested for each item by computing the S-χ^2 statistics (Orlando and Thissen, 2000). Significant S-χ^2 statistics indicate that the item did not fit under the model (Hambleton et al., 1991; Hambleton and Han, 2005). Given that using larger samples results in a greater likelihood of significant chi-square differences, the critical value of 0.01 rather than the usual critical value of 0.05 was employed (Stone and Zhang, 2003).

The DIF detection procedure is based on a nested model comparison approach. First, a more parsimonious model is tested with all parameters (β and α) constrained to be equal across groups for a studied item against an augmented model. Here, one or more parameters of studied item are freed to be estimated distinctly for the two groups (a focal group and a reference group). This procedure involves comparing differences in log-likelihoods (distributed as chi-square) associated with nested models. Since multiple tests were performed, the level of significance of 0.05 was adjusted by Bonferroni correction to 0.003 (0.05/16).

Finally, gender differences were investigated by looking at the item distribution by gender and by comparing across genders the total score of the IRT-based GBS-A score and the distribution of non-problem, at-risk, and disordered gamblers.

RESULTS

Results showed that 30% of the participants had never gambled. We performed the analyses on adolescent gamblers, i.e., the 1,201 respondents (59% males, mean age = 15.66, SD = 1.71) who affirmed having gambled at least once during the last year. Concerning missing data treatment, when missing values did exceed 10% of total answers, cases were excluded. When missing values did not exceed 10% of total answers, the *Expectation-Maximization* (EM) estimation method (Bock and Aitkin, 1981) was used to replace missing data. Only 1.2% (n = 14) of the respondents were excluded, thus IRT analyses were performed on a sample of 1,187 cases (59% males, mean age: 15.66, SD = 1.71).

Data showed that the groups of male and female gamblers were homogeneous in terms of age (Male adolescents: mean age = 15.68, SD = 1.67; Female adolescents: mean age = 15.65, SD = 1.77, p = 0.766), and level of education (Male adolescents: 11% middle school, 89% high school; Female adolescents: 14% middle school, 86% high school, p = 0.139).

Concerning descriptive data relative to the GBS-A first section, results showed that the most engaged gambling activities among boys were bets on sport games, scratch cards, and bingo, while girls preferred to gamble on bingo, followed by scratch cards and card games. Furthermore, while boys were used to gamble with friends, girls preferred someone of the family (**Table 1**). Additionally, male (M = 3.24, SD = 2.17) and female adolescents (M = 3.06, SD = 1.93) gambled on a similar number of activities [$t_{(1,\ 185)}$ = 1.46, p = *0*.145]. Finally, boys (M = 29.67 €, SD = 48.43) spent higher amount of money on gambling than girls (M = 18.75 €, SD = 41.47) [$t_{(755)}$ = 4.40, $p < 0.001$, Cohen's d = 0.24].

Gender Measurement Invariance

The results confirmed that a single factor model adequately represented the structure of the scale for each group, as none of the LD statistics were >10. The Samejima's (1969) GRM model was tested. Both in male and female gamblers, each item had a non-significant ($p > 0.01$) S-χ^2 value (**Table 2**), indicating that all items fit under the GRM model.

The gender DIF analyses (in which the male group was the reference group) showed from the first step that no items showed DIF (item DIF statistics ranged from 0.0 to 5.9, with associated p-values ranging from 0.979 to 0.053; **Table 2**). Thus, the GBS-A can be considered invariant across genders. Concerning the parameters, the GRM is a two-parameter model referring to the item severity and discrimination. Specifically, given the 3-point response format of the scale, two threshold parameters (β_i)—equal to the number of response options minus 1—are derived indicating the trait level where there is a 0.5 probability of endorsing the relevant response option or higher response options. Values can be interpreted as the "severity" of the symptom described by the item, i.e., higher the level of the trait

TABLE 1 | Gambling frequency for each activity and for gambling partners by gender.

Gambling activities	Never		Sometimes in the year		Sometimes in the month		Sometimes in the week		Daily		Total gamblers	
	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)
Card games	53.5	57.8	26.9	28.3	10.3	9.4	7.3	3.3	2.0	1.2	46.5	42.2
Bets on games of personal skill	71.0	68.6	16.5	20.7	7.9	8.2	3.3	2.0	1.4	0.4	29.0	31.4
Bets on sport games	44.2	74.0	17.3	13.9	14.6	5.1	19.0	4.7	4.9	2.3	55.8	26.0
Bets on horse races	91.3	90.0	5.2	6.8	2.1	1.4	1.1	1.6	0.3	0.2	8.7	10.0
Bingo	52.8	38.7	38.9	50.2	5.7	7.8	1.7	2.7	0.9	0.6	47.2	61.3
Slot machines	89.1	94.1	6.3	4.9	2.3	1.0	1.6	–	0.7	–	10.9	5.9
Scratch cards	46.9	41.6	34.8	43.6	13.9	11.1	3.1	3.1	1.3	0.6	53.1	58.4
Lotteries	75.3	74.8	17.5	19.3	4.3	3.3	2.3	2.0	0.7	0.6	24.7	25.2
Online games	81.7	84.8	7.2	6.8	3.1	3.3	4.0	3.1	4.0	2.0	18.3	15.2
Private bets with friends	75.8	86.4	11.8	10.4	7.3	1.6	3.4	1.6	1.7	–	24.2	13.6

Gambling partners	Never		Sometimes		Often		Total gamblers	
	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)
Alone	71.4	87.2	20.5	9.3	8.0	3.5	28.6	12.8
With friends	29.3	47.9	36.4	37.5	34.3	14.5	70.7	52.1
With boyfriend/girlfriend	81.1	76.0	13.3	17.2	5.7	6.8	18.9	24.0
With someone of the family	37.1	21.0	36.9	45.3	26.0	33.6	62.9	79.0

The percentages are in relation to the gender variable.

TABLE 2 | Fit statistics, parameters for each item of the GBS-A for gender groups, and DIF analysis of discrimination and severity parameters across genders.

		Males					Females					aDIF			bDIF		
Item	DSM-5 criterion	S-χ^2 (*df*)	*p*	a (SE)	b_1 (SE)	b_2 (SE)	S-χ^2 (df)	*p*	a (SE)	b_1 (SE)	b_2 (SE)	χ^2	*df*	*p*	χ^2	*df*	*p*
1	Tolerance	11.15 (12)	0.517	3.56 (0.54)	1.52 (0.13)	2.71 (0.27)	3.89 (7)	0.793	3.27 (0.82)	1.92 (0.19)	3.07 (0.41)	0.1	1	0.707	0.3	2	0.869
2	Withdrawal	16.19 (17)	0.512	3.00 (0.43)	1.37 (0.12)	2.17 (0.20)	19.71 (10)	0.032	2.82 (1.22)	1.91 (0.25)	2.78 (0.48)	0.2	1	0.622	1.8	2	0.414
3	Loss of control	20.30 (16)	0.207	3.42 (0.60)	1.56 (0.13)	2.27 (0.21)	7.69 (8)	0.465	2.20 (0.42)	2.15 (0.24)	3.33 (0.51)	1.0	1	0.311	0.7	2	0.708
4	Preoccupation	36.07 (19)	0.012	1.98 (0.25)	1.16 (0.11)	2.04 (0.20)	10.62 (13)	0.644	1.65 (0.29)	1.77 (0.22)	2.61 (0.34)	0.0	1	0.979	3.4	2	0.186
5	Escape	15.68 (16)	0.477	2.34 (0.36)	1.59 (0.15)	2.76 (0.30)	6.04 (5)	0.304	2.40 (0.41)	1.63 (0.16)	3.73 (0.63)	0.8	1	0.386	5.2	2	0.074
6	Chasing	15.40 (16)	0.497	1.86 (0.22)	0.75 (0.09)	2.53 (0.24)	15.90 (10)	0.102	1.35 (0.22)	0.96 (0.14)	3.40 (0.48)	0.5	1	0.467	2.0	2	0.368
7	Lying	15.36 (18)	0.638	2.58 (0.35)	1.35 (0.12)	2.31 (0.22)	6.30 (8)	0.614	2.29 (0.47)	2.04 (0.22)	3.45 (0.52)	0.1	1	0.809	5.9	2	0.053
8	Risked/lost relationships, opportunities	16.01 (14)	0.312	3.27 (0.76)	1.58 (0.15)	2.46 (0.28)	14.74 (8)	0.064	3.34 (0.44)	1.73 (0.13)	2.63 (0.24)	0.1	1	0.719	4.3	2	0.117
9	Bail-out	25.12 (21)	0.241	1.78 (0.23)	1.42 (0.15)	2.74 (0.30)	13.68 (11)	0.251	1.85 (0.32)	1.71 (0.21)	3.22 (0.45)	0.9	1	0.339	0.7	2	0.714

Parameters were computed under the GRM model (a, discrimination; b, severity). df, degrees of freedom; SE, standard error. Due to the large sample size α was fixed at 0.01.

on which the threshold are located, higher the severity of the item. Since in both groups the β_1 values were around 1 *SD* above the mean trait level (fixed at 0.00, $SD = 1.00$, by default) and β_2 at around 2 *SDs* above the mean trait level, all items can be considered very severe. The discrimination parameter (*a*) indicates the ability of an item to discriminate among people holding different levels of the underlying trait. According to Baker and Kim (2004), values 0.01–0.24 are very low, 0.25–0.64

are low, 0.65–1.34 are moderate, 1.35–1.69 are high, and more than 1.7 are very high. The item *a* values (between 1.78 ± 0.23 and 3.56 ± 0.54 among male gamblers and between 1.34 ± 0.22 and 3.34 ± 0.44 among female) indicated a high or very high discriminative ability.

Gender Differences

The descriptive statistics for each item were calculated for boys and girls (**Table 3**). Overall, results showed slightly higher percentages of "never" responses in girls. As such, boys showed higher endorsement of the "sometimes" and "often" options. However, the distributions for tolerance, escape, chasing and risked/lost relationships and opportunities items/criterions were quite similar.

Considering the total score of the GBS-A, results showed that the IRT-based score values ranged from 0 to 18.90 among boys and from 0 to 16.90 among girls. A significant difference was found between male ($M = 1.73$, $SD = 3.01$) and female adolescents ($M = 1.12$. $SD = 2.18$), who showed significantly [$t_{(1185)} = 3.86$, $p < 0.001$, Cohen's $d = 0.23$] lower values.

According to the criterion described by Primi et al. (2015), adolescents were classified into non-problem gamblers, at-risk gamblers, and disordered gamblers. There was a significant difference in the percentage distribution of the three categories of gamblers between boys and girls [$\chi^2(2, N = 1{,}187) = 15.21$, $p < 0.001$, *V Cramer* $= 0.113$]. More girls than boys were *non-problem gamblers* (90 and 81%, respectively), while boys showed higher rates of *at-risk gambling* (12%) and *disordered gambling* (7%) than girls did (7 and 3%, respectively).

DISCUSSION

Gender differences in adolescent gambling behavior have been widely documented and discussed (see Merkouris et al., 2016, for a recent systematic review). Consistent with past research (e.g., Donati et al., 2013), this study confirmed gender-specific preferences in engagement on gambling. Indeed, boys preferred to gamble on bets on sport games and girls on bingo, male adolescents gambled mostly with friends while female adolescents with someone of the family. Furthermore, the fact that boys spent more money on gambling than girls is in line with past studies (e.g., Felsher et al., 2004). Given these differences in gambling habits, it is important to deeply investigate gender differences related to GD symptoms.

Indeed, as research has found substantial gender differences in the prevalence of pathological gambling (see Splevins et al., 2010; Calado et al., 2017, for reviews), it is important to analyze whether the scales used are invariant across male and female adolescent gamblers, following the suggestion that "*fair measurement requires that test scores have the same meaning across all relevant examinee groups*" (Reise and Waller, 2009, p. 37). Nevertheless, to the best of our knowledge, with one exception, the most internationally employed instruments have not proved to be invariant across genders. As a consequence, in comparing test scores between male and female adolescents, we cannot exclude that the instruments fail to measure the construct in the same way in boys and girls. By applying IRT analyses, this study shows that the GBS-A (Primi et al., 2015), a new instrument recently developed for measuring the severity of GD among youth, is invariant across genders, i.e., we attested the measurement equivalence of the scale when administered to male and female adolescents. This ensures that the GBS-A can be used to compare boys' and girls' measure of pathological gambling and group differences can be interpreted in terms of differences in the underlying construct.

This finding appears to be important for adolescent gambling research because the other tool for which the measurement invariance was tested, i.e., the MAGS (Molde et al., 2009), showed a differential functioning across genders. Additionally, results from research with adults have evidenced gender-related biases concerning the DSM diagnostic criteria for pathological gambling. In detail, using Rasch modeling techniques, Strong and Kahler (2007) found that, given the same latent trait, women were more likely to endorse gambling to escape. Through Multiple-Indicator Multiple-Cause (MIMIC) modeling, Sacco et al. (2011) confirmed the DIF across genders for escape criterion and also found that men were more likely to endorse preoccupation.

Along with GBS-A gender invariance, some other important results have been provided by this study. First, the scale has been found to be unidimensional both in male and female adolescent gamblers, in line with the definition of GD in the DSM-5. Second, IRT attested that item properties (i.e., severity and

TABLE 3 | Percentages of item endorsement for each response option of the GBS-A across genders.

		Males			Females		
Item	**DSM-5 criterion**	**Never**	**Sometimes**	**Often**	**Never**	**Sometimes**	**Often**
1	Tolerance	91.4	7.9	0.7	95.4	4.3	0.4
2	Withdrawal	88.0	8.9	3.1	94.7	4.3	1.0
3	Loss of control	91.8	6.0	2.1	94.9	4.5	0.6
4	Preoccupation	80.1	13.3	6.6	88.9	7.2	3.9
5	Escape	89.6	9.0	1.4	90.6	9.2	0.2
6	Chasing	70.7	25.9	3.4	73.0	24.8	2.3
7	Lying	86.6	10.6	2.9	94.5	5.1	0.4
8	Risked/lost relationships, opportunities	91.7	6.9	1.4	93.6	5.3	1.0
9	Bail-out	84.7	12.6	2.7	89.3	9.4	1.2

discrimination) in male and female adolescents were consistent with the aim of measuring GD efficiently. With regard to severity, both in boys and girls, all the items resulted to be located along the range of the continuum that the scale was aimed to measure accurately, i.e., from at-risk to disordered gambling behavior. This indicated that the items adequately covered the range of the latent trait. Concerning discrimination, the parameter estimates indicated that the items of the GBS-A were able to distinguish between the different levels of the trait in boys and girls.

Finally, the GBS-A resulted to relieve the expected gender difference in GD (e.g., Delfabbro et al., 2009; Molde et al., 2009; Donati et al., 2013; Gupta et al., 2013). Specifically, the gender-specific endorsement for each item option revealed higher affirmative endorsement rates in boys. As such, male adolescents resulted to have higher levels of GD compared with female adolescents and a higher prevalence of both at-risk gamblers and disordered gamblers was found among boys rather than girls. This finding confirms and strengths previous results on gambling gender difference in adolescence given the gender measurement equivalence of the scale employed to assess problem gambling.

In terms of practical implications, the GBS-A can therefore be used both in research and practice. As for research, it appears to be as a useful instrument to be used to identify male and female adolescent gamblers characterized by pathological levels of gambling and to analyze gender differences and similarities in the predictors of disordered gambling among adolescents. In this regard, relatively few studies have until now analyzed gender specificity of the predictors of pathological gambling in adolescents (e.g., Chalmers and Willoughby, 2006; Jackson et al., 2008; Donati et al., 2013); thus, it is not clear yet whether the predictors of gambling involvement are similar for male and female adolescents. By applying the GBS-A, future studies should be conducted in order to extend knowledge about this issue.

For practitioners, the GBS-A can be profitably used in educational interventions and clinical treatments. From an educational point of view, it could be used as a measurement tool to evaluate the effectiveness of preventive interventions aimed to reduce gambling behavior among male and female adolescents. Specifically, the scale can be applied to have a reliable and valid measurement of the situation of participants' gambling behavior at the baseline, after the intervention, and at the follow-up. Specifically, as reviewed by Edgren et al. (2016), among the most employed instruments to measure the severity of gambling problems in youth, only the SOGS-RA has been used to verify the effectiveness of preventive interventions in decreasing the severity of gambling problems (Hansen and Rossow, 2010; Donati et al., 2014). As regards its clinical application, the GBS-A could be used with at-risk adolescents in order to assess the severity of GD. Indeed, several studies have shown that substance abuse, excessive use of alcoholics and driving under the influence of alcohol are associated with pathological gambling behavior among adolescents (e.g., Gupta et al., 2004; Splevins et al., 2010; Gori et al., 2014). For these reasons, when juveniles with these problems are detected, it may be done an assessment of gambling behavior by applying the GBS-A.

The present study offers several notable strengths, e.g., the large sample size and the application of IRT models to analyze DIF of the GBS-A. Nevertheless, some limitations have to be acknowledged. Specifically, as we recruited our sample in schools, participants were all adolescents attending middle and high school, whereas students who dropped out of school or working adolescents were not included. Furthermore, whereas the characteristics of the gambling phenomenon of the present study measured with the GBS-A are in line with the international literature, this study has been conducted with Italian adolescents, and some limitations regarding external validity might be related to the specificity of the sample. To overcome these limitations, measurement equivalence across country should be verified in future studies by checking the invariance of the scale across national contexts. It should be also interesting to test the psychometric properties of the scale in different populations, such as clinical sample of adolescents.

In sum, overall our results provide evidence that the GBS-A is psychometrically appropriate to be used with boys and girls. Thus, it can be used by researchers and practitioners dealing with the issue of understanding, prevention and treatment of problem gambling among adolescents.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of APA and with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the ethical committees of each involved school.

AUTHOR CONTRIBUTIONS

MD developed the research project and conducted the test administration in the school classrooms. She developed the analyses and wrote the paper. FC collaborated in the data analyses and the paper writing. VI collaborated in the test administration and data enter/analyses, while CP supervised the entire work and gave her contribution in the finding discussion.

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Psychometric Characteristics of a New Scale for Measuring Self-efficacy in the Regulation of Gambling Behavior

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Since its introduction in 1977, self-efficacy has proven to be a fundamental predictor of positive adjustment and achievement in many domains. In problem gambling studies, self-efficacy has been defined mainly as an individual's ability to avoid gambling in risky situations. The interest in this construct developed mainly with regard to treatment approaches, where abstinence from gambling is required. Very little is known, however, regarding self-efficacy as a protective factor for problem gambling. This study aims to fill this gap, proposing a new self-efficacy scale which measures not only the ability to restrain oneself from gambling but also the ability to self-regulate one's gambling behavior. Two studies were conducted in which the data from two Italian prevalence surveys on problem gambling were considered. A total of about 6,000 participants were involved. In the first study, the psychometric characteristics of this new self-efficacy scale were investigated through exploratory and confirmatory factor analyses. The results indicated the presence of two different factors: self-efficacy in self-regulating gambling behavior and self-efficacy in avoiding risky gambling behavior. The second study confirmed the replicability of the two-factor solution and displayed high correlations among these two self-efficacy dimensions and different measures of gambling activities as well as other psychological variables related to gambling (gambling beliefs, gambling motivation, risk propensity, and impulsiveness). The results of logistic regression analyses showed the particular importance of self-regulating gaming behavior in explaining problem gambling as measured by Problem Gambling Severity Index and South Oaks Gambling Screen, thus proving the role of self-efficacy as a pivotal protective factor for problem gambling.

Keywords: self-efficacy, scale development, problem gambling, validation, factor analyses, logistic regression analysis

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INTRODUCTION

This study addresses the role of self-efficacy beliefs as a protective factor for problem gambling. In particular, a new scale for measuring self-efficacy beliefs related to the regulation of one's own gambling behavior is presented. In the gambling literature, self-efficacy has been examined particularly in the context of treatment of pathological gambling, and the measures that have been

developed are framed within this context, with emphasis on the ability of the patient to restrain from gambling in situations where gambling behavior is probable. However, we believe that self-efficacy is also crucial when a gambler who is not in treatment is faced with the task of regulating his or her own gaming behavior in order to not engage in excessive gambling. Moreover, a scale focused mainly on the avoidance of gambling would be of limited use in large population and epidemiological studies, where the aim is to identify those variables that may represent protective and risk factors for the development of gambling problems.

THEORETICAL FRAMEWORK: SELF-EFFICACY WITHIN SOCIAL COGNITIVE THEORY

Self-efficacy represents a crucial construct within social cognitive theory (SCT, Bandura, 1986, 1997), which is focused on the acquisition of cognitive, social, emotional, and behavioral competencies as well as on the motivation and self-regulation of behavior. SCT is framed within an agentic perspective, which sees people as self-organizing, proactive, self-reflecting, and self-regulating organisms. As *agents*, people are capable of intentionally influencing their own functioning and life circumstances. Among the mechanisms of human agency considered in Bandura's theory, none is more focal or pervasive than self-efficacy beliefs (Bandura, 1991, 1997). These are individuals' beliefs regarding their ability to successfully produce given outcomes.

Self-efficacy beliefs are the basic determinants of several factors: the activities people choose; the efforts they expend in these activities; their perseverance when faced with setbacks and failures; and their causal attributions for successes and failures. Indeed, unless people believe they can produce desired results by their actions, they have little incentive to act or to persevere in the face of difficulties. Self-efficacy beliefs are dynamic factors, not general, static personality traits. They vary in magnitude depending on the difficulty of the task, their generality (some beliefs are related to specific domains while others involve a more generalized sense of mastery) and the strength with which they are held. Whatever other factors may operate as guides and motivators, they are nonetheless rooted in the core belief that one has the power to produce effects by one's actions.

Findings from different studies have demonstrated the influential role of self-efficacy beliefs in various domains of functioning (for an earlier review, see Bandura, 1997), such as learning (e.g., Pajares and Urdan, 2006), work (e.g., Judge et al., 2007), sport (Moritz et al., 2000), health and well-being (e.g., Karademas, 2006; Strobel et al., 2011), and social adjustment (e.g., Bandura et al., 2003). In these various domains, the assessment of specific self-efficacy beliefs has proven to be crucial in predicting or explaining specific behavioral outcomes (Bandura and Locke, 2003). Indeed, the specificity of self-efficacy beliefs as expressions of contextual knowledge and specific capacities has proven to be critical in studying the properties as well as the explanatory power of self-efficacy across tasks and situations. In the domain of addictive behaviors, this view is further reinforced by DiClemente et al. (1995), who argue that a measurement of self-efficacy must refer to situations that are specific to the addictive behavior considered.

MEASURING SELF-EFFICACY IN THE DOMAIN OF GAMBLING

Several self-efficacy scales have been developed in the domain of gambling behavior. These have been mainly focused on providing practitioners with measures to be used for the evaluation of treatment intervention aimed at reducing patients' pathological gambling. The two more commonly used scales are the Gambling Self-Efficacy Questionnaire (GSEQ) (May et al., 2003) and the Gambling Refusal Self-Efficacy Questionnaire (GRSEQ) (Casey et al., 2008).

Both scales stemmed from previous measures of self-efficacy related to alcohol addiction: the SCQ-39 (Annis and Graham, 1988) and the DRSEQ (for the GSEQ, see Young and Oei, 1996; for the GRSEQ, see Young et al., 1991). Both have been developed with consideration to the broad situational classes of factors that, according to Marlatt (1985), represent the determinants of addictive behavior and of relapse. These factors include unpleasant and pleasant emotions, physical discomfort, testing of personal control, urges and temptations, interpersonal conflicts, social pressure, and pleasant interpersonal interactions. Factor analyses indicated the presence of a single general factor for the GSEQ (see May et al., 2003; Winfree et al., 2014) or of very highly correlated factors for the GRSEQ (see Casey et al., 2008). GSEQ showed high internal consistency and high test-retest reliability (May et al., 2003); also GRSEQ showed high internal consistency for both the scales based on the 4-factor solution as well as for the overall scale derived by aggregating all the 26 items. GSEQ resulted negatively correlated with SOGS and DSM-IV indicators of problem gambling, and showed adequate reliability, sensitivity, specificity, and clinical significance: cut-off scores were developed and supported for using this measure with patients in treatment for gambling (Winfree et al., 2014). GRSEQ resulted negatively correlated with several measures of gambling problems (such as the SOGS) and with measures of distress (such as Depression, Anxiety, and Stress); it also resulted to discriminate adequately between non-problematic and problematic gamblers, as well as in pre- and post-treatment comparisons (Casey et al., 2008). Both scales have been used in rather small and non-representative samples: neither of them has been used in population studies or on representative samples of gamblers (Casey et al., 2008; Winfree et al., 2014).

GSEQ is essentially focused on the ability to control one's gambling behavior in situations that present increased odds of risky behavior (e.g., a situation in which the gambler meets a friend who suggests that they "go gambling together," thus exposing the gambler to social pressure, or in which a person feels an urgent desire to gamble). GRSEQ is essentially focused on an individual's ability to refuse to gamble in high-risk situations (e.g., when the person is in a place where he or she usually gambles, or when the person smokes tobacco). Although the

items in the scales feature different wording and response formats (GSEQ: *I would be able to control my gambling*; GRSEQ: *How confident are you that you could refuse gambling?*), they present large areas of overlap, and both are related to resisting or avoiding gambling in situations which may present increased odds of high-risk gambling behavior. None of them refer to specific agentic behaviors that allow the gambler to self-regulate his/her own gambling behavior.

SELF-REGULATION OF GAMBLING BEHAVIOUR

As noted by Bandura (2007), "there is more to self-regulation of substance abuse, of course, than resisting pressures to consume an addictive substance" (p. 643). What Bandura says regarding substance abuse can be easily extended to problem gambling, excessive gambling, and pathological gambling. As noted above, in the domain of problem gambling research, assessment, and treatment have focused on perceived *resistance* self-efficacy. Although the ability to resist interpersonal and intrapersonal pressures to gamble is fundamental, other facets of self-efficacy may come into play in successful regulation of gambling behavior. One particularly relevant aspect is the ability to reduce harm (e.g., by restricting potential losses within gambling sessions through the exercise of controlled gambling). This refers to the ability to regulate one's own gambling behavior by acting in a way that may protect one from excessive gambling. This aspect is at the core of self-regulation mechanisms since it deals with the ability to set behavioral goals and to monitor one's own gambling behaviors. These aspects are particularly strengthened by the self-regulation, self-assessment, and self-limiting tools available in responsible gambling programs (e.g., Blaszczynski et al., 2004). Indeed, as noted by Wood and Griffiths, 2015, responsible gambling strategies aim to encourage players to restrict their gambling to a non-problematic level. In order to keep their behavior under control, players are encouraged to gain knowledge of their behavior through feedback related to their gambling, such as the amount of money they have spent and the frequency with which they play. They are also encouraged to "pre-commit" to limits on the money and the time they may spend gambling; they are urged to stick to these limits by self-excluding when the limits are reached, by taking breaks in their play, and by taking self-diagnostic tests to monitor their gambling behavior. In this regard, Wood and Griffiths (2015) recently demonstrated that *positive players* (i.e., players whose behavior and attitudes do not exhibit problems or elicit concerns with regard to their gambling) adopt the following as personal strategies for responsible gambling: setting spending limits before playing, evaluating how much they can afford to lose before playing and setting time limits for playing. As noted by the authors, "these strategies are associated with a positive play experience" (Wood and Griffiths, 2015, p. 1,729), while the absence of these strategies is significantly associated with problematic gambling. In this regard, these players' proactive stances are consistent with the stress placed by Blaszczynski et al. (2004) on individuals' personal responsibility in their level of gambling participation as a basic tenet of responsible gambling.

From these premises and considerations, a new scale for measuring self-efficacy related to gambling behavior has been developed, and its characteristics are presented in this paper. The scale aims to overcome the limits of both GSEQ and GRSEQ by making available an instrument focused not only on avoidance and refusal to gamble in risky situations but also on the proactive self-regulation of gaming behavior conducive to positive play and, thus, to the prevention of excessive gambling. This instrument would, as a result, be more suited for use in large population studies on gamblers not involved in psychological treatment. In this paper, we present two studies that are focused on the psychometric characteristics of the scale as far as the internal structure of the items is concerned, the correlation with other measures related to gambling behaviors and the impact of self-efficacy as a protective factor for problem gambling.

STUDY 1: PSYCHOMETRIC CHARACTERISTICS OF THE MULTIDIMENSIONAL GAMBLING SELF-EFFICACY SCALE

The main aim of the first study was to examine the factorial structure and reliability of the Multidimensional Gambling Self-Efficacy Scale (MGSES)—a new scale for measuring gambling self-efficacy—in two large and representative samples of gamblers. First, we will provide details about the process used to develop the initial pool of items included in the scale. Second, we will present the results of the dimensionality and reliability/internal consistency analyses.

Method

Participants

This study considered two independent samples: (a) an *overall* sample of players reflecting the overall population of gamblers who gambled at least once in the 12 months before the data collection at any game involving money, without any reference to the type of game played to be used as an inclusion criterion; (b) a smaller sample of players who, in the 12 months before the data collection, gambled at least once at any *online* game involving money.

Each sample was representative of their respective populations of *overall* and *online* adult Italian gamblers (18 years or older). The *overall* sample consisted of 2,015 participants, 54% of whom were males. Their ages ranged from 18 to 87 years ($M = 47.43$, $SD = 15.43$). In terms of education, 18% had not continued past elementary studies; 40% had stopped at primary studies, 33% had stopped at secondary studies; and 9% had stopped at university studies. Of the participants, 25% were single, 64% were married and 11% were separated or widowed. Their modal occupations included employers/office workers (16%), manual workers (19%), and retirees (20%). The *online* sample consisted of 1,005 participants, 67% of whom were male. Their ages ranged from 18 to 64 years ($M = 37.55$, $SD = 12.42$). Of these, 1% had undergone only elementary studies; 12% had

stopped at primary studies; 57% had stopped at secondary studies; and 30% had stopped at university studies. In terms of marriage status, 45% were single, 51% were married and 5% were separated or widowed. Their modal occupations were included employers/office workers (32%), manual workers (10%), and students (14%).

Regarding the gambling behavior exhibited in the last 12 months, participants in the *overall* sample played an average of about three different games ($M = 3.5$, $SD = 2.44$). The most played games were instant lotteries (84%) and lotto/other lotteries (81%); betting was played by about 17%, slots/VLT by about 12%, bingo as well as online games by about 11%, games at casinos by about 2%. Seventy-eight percentage of participants dedicated less than 30 min per day to gambling, while participants who gambled for 2 h or more per day were 4%. Participants whose maximum daily expense for gambling was less than 20 Euros were 86%, while those whose maximum daily expense for gambling was higher than 100 Euros were 3%. About 4% of participant had one or both parents who are or used to be excessive gamblers. Participants in the *online* sample played an average of about 11 different games ($M = 10.79$, $SD = 6.6$). All participants played online, since having played online at least once was the criterion for inclusion in the research. Considering games played online, the most played games were betting (63%), poker (55%), lotto (45%), casino games (40%). Considering games not played online, the most played games were lotto/other lotteries (86%), instant lotteries (79%), and betting (70%); slots/VLT were played by about 41%, bingo by about 40%, games at casinos by about 26%. Twenty-five percentage of participants dedicated less than 30 min per day to gambling, while participants who gambled for 2 h or more per day were 17%. Participants whose maximum daily expense for gambling was less than 20 Euros were 70%, while those whose maximum daily expense for gambling was higher than 100 Euros were 7%.About 15% of participant had one or both parents who are or used to be excessive gamblers. These different patterns of gambling behaviors further confirm the diversity of the two samples considered.

Procedure

Data were collected by Ipsos, one of the leading market research organizations operating in Italy (http://www.ipsos.it/), in October and November 2012 within a national study on the prevalence of problem gambling, and on risk and protective factors for problem gambling in Italy. The target number of subject (2,000 and 1,000 respectively in the *overall* and in the *online* samples) was defined in order to have a standard error of the 95% confidence interval for prevalence estimates of 1% in the *overall* sample and of 2% in the *online* sample. A quota sampling strategy, balanced by geographical area (including four areas), city size (including five groups), and age/gender (including 12 groups), was used. For the *overall* sample, participants were contacted by an interviewer and invited to fill out a questionnaire of about 300 items. The questionnaire was individually administered to participants in their homes. For the *online* sample, participants were administered a questionnaire of about 250 items using the Computer Assisted Web Interviewing (CAWI) methodology. Persons who initially agreed to participate but later declined were replaced by other participants with homogeneous characteristics. Individuals received a fee of about 20 Euros for their participation. After data collection was complete, participants were weighted in order to maximize the sample's representativeness of the target population. The ethic Committee of CIRMPA—Sapienza University of Rome approved the research. Ethical procedures concerning privacy, anonymity and confidential treatment of data were respected: an informed consent sheet was signed by all participants before the questionnaire and interview were administered. All participants were allowed to leave the study at any time. All procedures were performed in accordance with the ethical standards of the institutional and/or national research committee.[1]

Materials

The questionnaire administered comprised different scales. In particular, a first set of variables measured gambling behavior (number of games played, types of games, etc.), a second set comprised indicators of problem gambling (PGSI and SOGS), a third set comprised possible risk factors (e.g., beliefs about gambling, motivation to gamble, etc.) and protective factors (e.g., self-efficacy, life-satisfaction, etc.) for problem gambling, a fourth set comprised variables that might represent other possible sources of risk or of comorbidity for problem gambling (e.g., impulsiveness, risk propensity, depression, life events, psychological distress, etc.). A final set comprised variables related to respondents' perception of the problem gambling phenomenon.

Among the scales administered in the survey, we considered in this first study only the MGSES. As noted in the introduction, this new self-efficacy scale was developed to overcome the limitations of the previous measures of gambling self-efficacy. Following a "top-down" approach the items were generated after an inspection of the scientific literature regarding self-regulatory processes related to problem gambling, and self-regulation, self-assessment, and self-limiting processes stressed within responsible gambling tools and programs. Two sets of items were then developed with the aim of defining two different self-efficacy subscales. The first set was comprised of items that were essentially focused on the avoidance of gambling in situations that (according to the examined literature) exposed gamblers to a risk of excessive gambling. These situations resulted substantially consistent with those considered in other scales aimed at assessing self-efficacy in the domain of gambling. The self-efficacy in avoiding gambling behavior scale was then

[1] As far as the check of the quality of the data is concerned, different analyses have been performed prior to substantial data analyses. In particular, the analysis of the pattern of missing values revealed that about 98% of the overall sample presented a percentage of missing value lower than 5%. In the online sample, no missing values were appreciated. Since a social desirability scale (composed by items from the Lie Scale of the Big Five Questionnaire, the personality questionnaire most used in Italy on adult samples) was administered in both samples, we also investigated the possibility of the prevalence of social desirable or of socially undesirable responses. In both sample the distribution of this scale scores was fairly normal (with kurtosis and skewness close to 0). Moreover, no significant differences emerged in this scale when problematic and non-problematic gamblers (classified using SOGS and PGSI) were compared.

assembled. It was comprised of 11 items assessing the degree to which players perceive themselves to be capable of avoiding gambling in the following circumstances: (a) when under stress or when experiencing negative affects/states; (b) during leisure time; (c) when in social situations; (d) when in conflict situations; and (e) when feeling the urge to play. A second set was comprised of items essentially focused on reducing the probability of harmful outcomes of gambling through the exercise of controlled gambling. These items refer to the ability to regulate one's own gambling by acting in a way that may protect oneself from engaging in excessive gambling. The items content was based upon those responsible gambling strategies aimed at encouraging players to restrict their gambling to a non-problematic level and to pursue a "positive playing" (see Wood and Griffiths, 2015). The self-efficacy in self-regulating gambling behavior scale was then assembled. It was comprised of six items assessing the degree to which a gambler was capable of the following: (a) spending only the amount of money initially decided upon; (b) ceasing play when a pre-decided time limit was reached; (c) avoiding spending in gambling the change or money that must be spent to buy other things; (d) sticking to one's decision not to play, despite temptation; and (e) stop playing to win back ("chasing" behavior). The formulation of the items was discussed with three experts working since at least 5 years in the field of responsible gambling programs (one was a psychologist and the other two were graduated in other disciplines). The feedback of the three experts was used as a check for the completeness of the situations and of the behaviors examined in the scale. Experts' opinions helped furthermore in the clarification of the item wording (see Schuman and Presser, 1996). All 17 items of the two subscales, as well as the complete five-step response formats (from 1 = not at all, to 5 = completely) are reported in the Appendix in Supplementary Materials.

Data Analysis

Items were first evaluated in terms of descriptive statistics and univariate normality. Then, a cross-validation procedure (Byrne, 2010) was applied to assess the factorial structure of MGSES. Specifically, an exploratory factor analysis (EFA) was conducted, first on the *overall* sample. In this EFA, the number of factors to retain was identified by means of a parallel analysis (see Hayton et al., 2004) comparing the real data eigenvalues with those derived from random artificially generated data, maintaining the same sample size and number of observed indicators. The factors to be retained were determined by the number of "real data" eigenvalues that were higher than the corresponding number derived from random datasets. Fit indices of the final EFA model were also computed. The fit of the final EFA solution was compared, by means of a chi-square difference test, to that of a solution with the same number of factors suggested by parallel analysis, minus one. Geomin factor rotation was used for the EFA model (see Muthén and Muthén, 1998-2016). Once the final factorial solutions were calibrated with EFA on the *overall* sample, a confirmatory factor analysis (CFA) was performed to cross-validate the factorial structure on the *online* sample. Since the two samples present substantial differences with respect to demographic characteristics, pattern of gambling, inclusion criteria and method of assessment, we believe these differences would substantially reduce the probability to obtain replicable results only by chance, and enhance the value of the replicable results obtained. The overall model fit was evaluated using a multifaceted approach including the following (Kline, 2016): (i) chi-square test; (ii) Root Mean Square Error of Approximation (RMSEA, Steiger, 1990; MacCallum et al., 1996; if $\leq$ 0.08, the model shows a good fit); iii) Comparative Fit Index (CFI, Bentler, 1990; if $\geq$ 0.90, the model shows an acceptable fit); and (iv) Standardized Root Mean Squared Residual (SRMR, Hu and Bentler, 1999; if $\leq$ 0.08, the model shows an acceptable fit). The reliability of MGSES dimensions was evaluated in both samples in terms of internal consistency with the Cronbach's alpha coefficient.

Results

Descriptive Statistics

Table 1 shows a summary of descriptive of MGSES items in both the *overall* and *online* samples. Skewness and kurtosis values (especially in the *overall* sample) suggest that the distributions of items do not perfectly fit univariate normality assumptions. Specifically, items mainly present negatively skewed distributions (Tabachnick and Fidell, 2007). These will be taken into account for further analyses using robust estimators in order to deal with these departures from univariate normality.

Factorial Structure and Reliability of MGSES

Given the distribution of MGSES items in both samples, EFA and CFA were carried out using Robust Maximum Likelihood estimators (MLR in Mplus software; see Muthén and Muthén, 1998-2016). The first three real data eigenvalues were 10.62, 1.75,

TABLE 1 | Summary descriptive Statistics of MGSES Items in *overall* and *online* Samples.

	***Overall* sample (*N* = 2,015)**				***Online* sample (*N* = 1,005)**			
	Min	**Max**	***M***	***SD***	**Min**	**Max**	***M***	***SD***
M	4.05	4.51	4.23	0.16	3.53	4.06	3.77	0.15
SD	0.82	1.15	1.01	0.11	1.04	1.19	1.12	0.05
Skewness	−1.90	−0.88	−1.26	0.30	−0.79	−0.24	−0.54	0.16
Kurtosis	−0.27	3.52	0.91	1.08	−0.89	−0.08	−0.56	0.22

M, Mean; SD, Standard Deviation.

and 0.76, while the first three eigenvalues associated with artificial data (based on 1,000 replications) were 1.16, 1.13, and 1.10. Therefore, parallel analysis suggests the presence of two factors. Moreover, the model comparison of the two-factor EFA model with a one-factor model suggests an improvement in model fit, $\Delta\chi^2_{(\Delta df=16)} = 1{,}995.998$ and $p < 0.001$. Thus, two factors were retained for the final EFA solution. The overall model fit was satisfying: $\chi^2_{(\mathrm{df}=103)} = 1{,}049.49$, $p < 0.001$, RMSEA = 0.068, CFI = 0.932, and SRMR = 0.029. In the left part of **Table 2**, factor loadings of the final Geomin oblique solution are presented. Consistent with the theoretical dimensions hypothesized when developing MGSES items, the two factors are clearly interpretable as *self-efficacy in self-regulating gambling behavior* (REG_SE) and *self-efficacy in avoiding gambling behavior* (AV_SE) since the final solution has a very simple structure in both samples, being all cross loadings lower than |0.20|. The correlation between factors was 0.69 ($p < 0.05$).

Once the EFA final solution was established, the factorial structure was replicated by means of CFA on the *online* sample. In terms of goodness of fit, the results were satisfying: $\chi^2_{(\mathrm{df}=118)} = 1{,}583.26$, $p < 0.001$, RMSEA = 0.079, CFI = 0.916, and SRMR = 0.033. Factor loadings are presented in the right part of **Table 2**, and they were all higher than 0.70. The correlation of latent factors was 0.78 ($p < 0.001$). As a check of the discriminant validity of the factors, a CFA model with a single factor was examined and then compared with the two-factor model. Results indicated that the single-factor model's fit with the data was much poorer than that of the two-factor model, with a $\Delta\chi^2_{(\Delta df=1)} = 1{,}544.19$ and $p < 0.001$. Cronbach's alphas in the *overall* sample were 0.93 and 0.96 respectively for REG_SE and for AV_SE, while in the *online* sample they were 0.94 and 0.96. respectively for REG_SE and for AV_SE.

TABLE 2 | Standardized factor loadings on both samples for the final two-factor EFA solution and from the CFA model.

	EFA—*Overall* sample (*N* = 2,015)		CFA—*Online* sample (*N* = 1,005)	
	REG_SE	AV_SE	REG_SE	AV_SE
it1	**0.89**	−0.03	0.87	
it2	**0.88**	0.01	0.87	
it3	**0.89**	−0.05	0.88	
it4	**0.82**	0.06	0.87	
it5	**0.57**	0.19	0.78	
it6	**0.73**	0.16	0.87	
it7	0.13	**0.74**		0.84
it8	0.07	**0.81**		0.87
it9	−0.02	**0.76**		0.76
it10	0.03	**0.84**		0.81
it11	0.02	**0.80**		0.77
it12	0.00	**0.75**		0.75
it13	−0.05	**0.91**		0.83
it14	−0.05	**0.91**		0.87
it15	−0.03	**0.81**		0.73
it16	0.01	**0.84**		0.83
it17	0.01	**0.84**		0.84

Principal factor loadings are presented in bold for the EFA solution. REG_SE, Self-efficacy in self-regulating gaming behavior; AV_SE, Self-efficacy in avoiding gambling behavior.

Discussion

Support for the structural validity and reliability of the MGSES is fully achieved in the results of this first study. Factor analysis showed that the 17 items clearly measure the two hypothesized dimensions of self-regulating and avoiding self-efficacy. Indeed, all of the items were good indicators of the intended factor, and the psychometric properties of these two scales were excellent. This was proven by the clear, simple factorial structure of solutions when examined by means of EFA, where all cross-loadings were negligible; the simple structure was further replicated through the thorough tests of CFA on a sample whose characteristics are rather different from those of the sample used for EFA, and this enhances the value of the replicable results (American Psychological Society, 2015). High Cronbach's alpha coefficients attested the internal coherence of the scales. We have to acknowledge that in order to completely establish reliability estimates, a test-retest coefficient had to be derived. Unfortunately, the design of the study did not allow to test for this type of reliability estimate. Finally, the discriminant validity of the two factors was supported by the poor fit reached by an alternative model in which a unique factor was posited. While the factor correlation indicated a solid stem common to the two dimensions, these two dimension were significantly different, thus representing two important facets or aspects of self-efficacy related to gambling behavior. Overall, the findings from this study provided evidence of the quality of the MGSES. Further investigations of the stability of this factorial structure and of the validity of the MGSES are presented in the following study.

STUDY 2: FACTORIAL SOLUTION REPLICABILITY, DISCRIMINANT, AND CRITERION VALIDITY OF THE MGSES

With this second study, we aimed to test both the replicability of the MGSES factor structure on two independent samples and its measurement invariance across different samples. Moreover, we aimed to test the criterion validity of the scale by examining the following: (a) the correlation of the two specific SE dimensions on relevant criteria/variables, including problem gambling measures, gambling behaviors, gambling beliefs, gambling motivation, and risk propensity; (b) the unique contribution of self-efficacy dimensions in explaining problem gambling by means of logistic regression analyses.

Method

Participants

This study, like the previous one, considered two different and independent samples: (a) an *overall* sample of players reflecting the overall population of gamblers who gambled at least once in the 12 months before the data collection at any game involving money, without any reference to the type of game played to be

used as an inclusion criterion; (b) a smaller sample of players who, in the 12 months before the data collection, gambled at least once at any *online* game involving money. As in study 1, the samples were representative of their respective populations of adult Italian gamblers. The *overall* sample consisted of 2,030 participants, 58% of whom were males. Their ages ranged from 18 to 87 years ($M = 48$, $SD = 16$). In terms of education, 17% had not continued past elementary studies; 43% had stopped at primary studies; 32% had stopped at secondary studies; and 8% had stopped at university studies. Of the participants, 26% were single, 61% were married and 13% were separated or widowed. Their modal occupations included employers/office workers (13%), manual workers (22%), housewives (14%), and retirees (20%). The *online* sample consisted of 1,000 participants, 70% of whom were males. Their ages ranged from 18 to 64 years ($M = 37.8$, $SD = 12.5$). Of the participants, 1% had not continued beyond elementary studies; 15% had stopped at primary studies; 57% had stopped at secondary studies; and 27% had stopped at university studies. In terms of marital status, 47% were single, 48% were married, and 5% were separated or widowed. Their modal occupations included employers/office workers (31%), manual workers (12%), and housewives (13%).

Regarding the gambling behavior exhibited in the last 12 months, participants in the *overall* sample played an average of about three different games ($M = 3.1$, $SD = 2.33$). The most played games were instant lotteries (82%) and lotto/other lotteries (73%); betting was played by about 14%, slots/VLT by about 13%, online games by about 12%, bingo by about 8%, games at casinos by about 2%. Seventy-four percentage of participants dedicated less than 30 min per day to gambling, while participants who gambled for 2 h or more per day were 6%. Participants whose maximum daily expense for gambling was less than 20 Euros were 83%, while those whose maximum daily expense for gambling was higher than 100 Euros were 1%. About 3% of participant has one or both parents who are or used to be excessive gamblers. Participants in the *online* sample played an average of about 11 different games ($M = 11.20$, $SD = 8.4$). As in study 1, all participants played online, since having played online at least once was the criterion for inclusion in the research. Considering games played online, the most played games were betting (62%), lotto (53%), and poker (44%). Considering games not played online, the most played games were lotto/other lotteries (77%), instant lotteries (73%), and betting (55%); slots/VLT were played by about 37%, bingo by about 37%, games at casinos by about 32%. Thirty-five percentage of participants dedicated less than 30 min per day to gambling, while participants who gambled for 2 h or more per day were 15%. Participants whose maximum daily expense for gambling was less than 20 Euros were 52%, while those whose maximum daily expense for gambling was higher than 100 Euros were 7%. About 12% of participant has one or both parents who are or used to be excessive gamblers. As in the case of study 1, these different patterns of gambling behaviors further confirm the diversity of the two samples considered.

Procedure

Data were collected by IPSOS in October and November 2014. The same procedures for sampling strategy, questionnaire administration, data collection and ethical issues used in study 1 were used also in study 2: we refer to study 1 for a detailed description.[2]

Materials

The questionnaire administered for study 2 comprised substantially the same sets of variables described in the methods section of study 1, to which we refer for a more detailed description. In particular, in study 2 we focused our attention on the following scales:

Multidimensional Gambling Self-Efficacy Scale (MGSES) described in Study 1. Factorial structure and reliability indices will be described in the results section, along with the measurement invariance tests.

Measures of Gambling Behaviors include gambling frequency, time spent gambling, the maximum amount of money spent gambling in a single day, the number of games played, the type of games played, and the familiarity (i.e., the presence in the gambler family) of the gambling problems.

Problem Gambling was measured by the Italian versions of SOGS and of PGSI (Barbaranelli et al., 2013). SOGS is a dichotomous 20-item scale that evaluates the presence of problem gambling (Lesieur and Blume, 1987). PGSI, another scale that measures problem gambling, uses 9 items that each have four response options, from 0 = never to 3 = almost always (Ferris and Wynne, 2001).The reliability of SOGS was 0.84 and 0.89, and the reliability of PGSI was 0.92 and 0.96, respectively, in the *overall* and *online* samples.

Erroneous Gambling Beliefs were assessed with 10 items from the Gamblers' Beliefs Questionnaire (Steenbergh et al., 2002). In particular, the items measured gamblers' erroneous beliefs: their overestimation of their control over the outcomes of games and, thus, their chances of winning (the illusion of control; e.g., *My knowledge and skill in gambling contribute to the likelihood that I will make money*) and their belief in the probability of a win if they continue to gamble (perseverance; e.g., *When I am gambling, "near misses"—moments when I almost win—remind me that, if I keep playing, I will win*). Previous factor analyses demonstrated the presence of a single factor underlying the 10 items. The reliability of the scale was 0.94 in both *overall* and *online* samples.

Gambling Motivations were assessed using 12 items adapted from the Motives for Gamble scale (Cotte, 1997; Rousseau and Venter, 2002). In particular, the items measured gamblers' symbolic motives (e.g., *Gambling is a way to show others that I am good*), economic motives (e.g., *Gambling is a good way to earn money*), and hedonic motives (e.g., *Gambling is an exciting pastime*). Previous factor analyses indicated the presence of three correlated factors underlying the 12 items. Reliability coefficients of the three scales in *overall* and *online* samples, respectively, were 0.90 and 0.86 for symbolic motives, 0.91 and 0.74 for hedonic motives and 0.87 and 0.91 for economic motives.

Risk taking was assessed with 11 items from the Stimulating Risk Taking scale (Zaleskiewicz, 2001) and from the Declared Risk Taking scale (Dahlbäck, 1990). These items measure an individual's propensity to take risks as a way of providing

[2] As in study 1 a check of the quality of the data was conducted prior to substantial data analyses. Results confirmed what emerged in study 1.

stimulation, excitement and arousal; (e.g., *Every time I take a risk, I experience a pleasant feeling of excitement*) and of declare the benefit to oneself of more often engaging in risky behaviors (e.g., *I think I am often less wary of other people*). Previous factor analyses evidenced the presence of a single factor underlying the 11 items. The reliability of the scale was 0.95 in both *overall* and *online* samples.

Impulsiveness was assessed with four items from the Self-Control scale (Tangney et al., 2004) and four items from Barratt Impulsiveness Scale (BIS, Patton et al., 1995). Self-control refers to "the ability to override or change one's inner responses, as well as to interrupt undesired behavioral tendencies and refrain from acting on them" (Tangney et al., 2004, p. 275; e.g., *Sometimes I cannot stop doing something, even though I know it is wrong*). BIS measures the personality trait of impulsiveness. In particular, we considered four items from the BIS Motor Impulsiveness subscale, which assesses the tendency to act on the spur of the moment and the consistency of one's lifestyle (e.g., *I act on the spur of the moment).* Previous factor analyses indicated the presence of a single factor underlying the eight items. The reliability of the scale was 0.84 in the *overall* sample and 0.87 in the *online* sample.

All scale items were rated with five response options (from 1 = doesn't describe me at all, to 5 = describes me very much), with the exception of MGSES, SOGS, and PGSI.

Data Analysis

The replicability of the two-factor structure of MGSES was evaluated by means of CFA in both samples, and these models were evaluated following the same fit criteria used in Study 1. Furthermore, measurement invariance (Meredith, 1993) of MGSES was tested by comparing series of nested multigroup confirmatory factor models (MG-CFA) ordered in terms of increasing complexity, considering separately: (a) *overall* vs. *online* samples, and (b) males vs. females. Specifically, for each of the two invariance analyses we first ran the two-factor CFA model simultaneously on two groups without imposing constraints on model parameters (this is called *configural invariance* model). In the second nested model, factor loadings were constrained to equality across groups (this is called *metric invariance* model), while in the third model, equality constraints were also applied on item intercepts (this is called *scalar invariance* model). Finally, the equality of residual variances was added to the scalar model (this is called *strict invariance* model). To evaluate whether constraints were tenable, statistical comparison among each adjacent couple of models was performed by means of ΔCFI (Cheung and Rensvold, 2002). If ΔCFI across adjacent models was< 0.01, the more parsimonious model could not be rejected.

The criterion validity of MGSES was assessed by zero-order correlations of its two dimensions with the aforementioned scales related to gambling (e.g., SOGS, PGSI, etc.) and with typical behavioral indicators of gambling (e.g., the number of games played in the last 3 months, average time per day spent playing, etc.). Due to the correlation between the two MGSES factors, partial correlations were also computed in order to better evaluate the association of each MGSES factor with the various variables considered, controlling for the other MGSES factor. Finally, hierarchical logistic regression was used to evaluate the unique contribution of MGSES dimensions above and beyond demographics and other relevant gambling-related variables in explaining problem gambling as a criterion variable obtained from a combined use of SOGS and PGSI (see Barbaranelli et al., 2013).

Results

Replicability of the MGSES Factorial Structure

For the *overall* sample, the fit was satisfying: $\chi^2_{(df=118)} = 1{,}127.45$, $p < 0.001$, RMSEA = 0.065, CFI = 0.938, and SRMR = 0.028. The latent correlation among the two MGSES factors was 0.76 ($p < 0.001$), and αs were, respectively, 0.94 for REG_SE and 0.96 for AV_SE. Also, for the *online* sample, the fit was satisfying: $\chi^2_{(df=118)} = 696.95$, $p < 0.001$, RMSEA = 0.070, CFI = 0.938, and SRMR = 0.029. Latent correlation among the two MGSES factors was 0.81 ($p < 0.001$) and alphas were, respectively, 0.94 for REG_SE and 0.96 for AV_SE. The factorial structure of MGSES derived from Study 1 closely fits the data of both samples considered for Study 2. Factor loadings for both samples are reported in **Table 3**. They are very high and are similar to those found in the Study 1 samples. As for Study 1, the two-factor model was compared with a single-factor model in order to evaluate the discriminate validity of MGSES dimensions. In both the *overall* and the *online* samples, the single-factor model produced a significantly inferior model fit, with a $\Delta\chi^2_{(\Delta df=1)} = 1{,}685.07$, $p < 0.001$ and a $\Delta\chi^2_{(\Delta df=1)} = 569.23$, $p < 0.001$, respectively.

TABLE 3 | Standardized factor loadings on both samples for the CFA model.

	***Overall* sample (N = 2,030)**		***Online* sample (N = 1,000)**	
	REG_SE	**AV_SE**	**REG_SE**	**AV_SE**
it1	0.85		0.88	
it2	0.89		0.88	
it3	0.86		0.87	
it4	0.89		0.89	
it5	0.76		0.80	
it6	0.88		0.89	
it7		0.86		0.89
it8		0.89		0.89
it9		0.73		0.81
it10		0.86		0.84
it11		0.83		0.86
it12		0.74		0.82
it13		0.88		0.83
it14		0.89		0.88
it15		0.78		0.79
it16		0.86		0.85
it17		0.86		0.88

REG_SE, Self-efficacy in self-regulating gaming behavior; AV_SE, Self-efficacy in avoiding gambling behavior.

Measurement Invariance of MGSES

Table 4 shows the results of the two measurement invariance tests performed respectively across samples and gender. First, the configural models adequately fit the data. When introducing constraints on factor loadings, the requirements for metric invariance tenability were met in both tests (i.e., gambling sample—*overall* vs. *online*—and gender). Then, multigroup constraints were set on item intercepts. These constraints did not significantly worsen models' fit, so the conditions of measurement scalar invariance were also satisfied for both tested cases. Finally, results from model for strict invariance suggest that constraints on residual variances of items were also tenable. In sum, MGSES reached the full strict invariance across the two testing conditions that were considered. This result is an important prerequisite not only for studying differences at the latent level between samples but also for making meaningful comparisons on the level of observed scores (DeShon, 2004). In this case, such a comparison would make sense both when considering different samples of gamblers (*overall* vs. *online*) and when focusing on gender differences (males vs. females).

Criterion Validity

Table 5 reports correlations of MGSES dimensions with other gambling-related measures. Correlations were all negative and statistically significant. These correlations were higher in the *overall* sample than in the *online* sample. Remarkably, both factors of MGSES were strongly and negatively associated with problem gambling measures. As noted above, since the two MGSEG factors were highly correlated, we computed partial correlation in order to measure the unique association of MGSES factors to the variables considered. As can be seen in **Table 5**, partial correlations clearly demonstrated that the association of REG_SE with all variables, although decreasing when controlling for AV_SE, remained high and significant in both samples. In its turn, AV_SE displayed a strong reduction in its association with all variables. However, its partial correlations remained significant among almost all variables especially in the *overall* sample. This indicates the added value of AV_SE with respect to the variance already accounted for by REG_SE. Remarkably, REG_SE was indicated to be the more important aspect of self-efficacy in that it was associated with the two measures of problem gambling, while AV_SE association was rather marginal.

Table 6 shows correlations among MGSES factors and some typical measures of gambling behavior. With regard to the number of games played in the last 12 or 3 months, similar correlations were detected with both MGSES dimensions across the two samples, with correlations in the *overall* sample generally higher than those in the *online* sample. The variables resulting in a higher correlation with MGSES were the number of games played, playing SLOTS/VLT, the maximum amount of money spent per day and the average time spent playing. We again obtained partial correlations for a better understanding of the unique association among MGSES factors and the various measures of gambling behavior. Notably, while the contribution of REG_SE almost always remained significant after controlling for AV_SE, the contribution of AV_SE disappeared when controlling for REG_SE with only a few exceptions and only in the *overall* sample. Again, REG_SE appears to be the crucial aspect of self-regulation associated with excessive gambling.

As a final step of criterion validity, two hierarchical logistic regressions (one per sample) were carried out in order to explain problem gambling defined on the basis of a combined use of SOGS and PGSI criteria. In Step 1, background variables (i.e., gender, age, education level, and income) were added to the regression model; in Step 2, gambling-related measures (including MGSES dimensions) were included. For sake of clarity in the results interpretation, REG_SE and AV_SE were re-coded so that higher scores reflected a higher lack of self-efficacy. The results are presented in **Table 7**. In both samples, background variables did not account for problem gambling, while the introduction of variables related to gambling in Step 2 significantly increased the explained variance of problem gambling. Nagelkerke's R^2 indicated, in both samples, a robust association between explanatory variables and the criterion in Step 2, and the increase in explanation was significantly high in both samples. In both samples, familiarity was the variable with the highest association with problem gambling, and REG_SE was the second most important variable. While in the *overall* sample, hedonic motivation was almost comparable to REG_SE in terms of explanatory magnitude (as captured by the odds ratio), in the *online* sample, none of the significant variables other than familiarity had a comparable relative importance with respect to REG_SE. This result further confirms the importance of this aspect of self-efficacy as a protective factor with respect to problem gambling. From a practical point of view, the result related to REG_SE means that the probability of finding a gambler lacking in self-efficacy is almost four times higher among problem gamblers than among non-problem gamblers.

TABLE 4 | Goodness of fit indices of CFA models for measurement invariance

Model	χ^2	df	RMSEA	CFI	SRMR	ΔCFI
CROSS-SAMPLE INVARIANCE						
Overall sample (n = 2,030)	1,127.45	118	0.065	0.938	0.030	–
Online Sample (n = 1,000)	696.95	118	0.070	0.928	0.029	–
Configural	1,838.90	236	0.067	0.938	0.030	–
Metric	1,960.97	251	0.067	0.934	0.043	0.004
Scalar	2,053.62	266	0.067	0.931	0.046	0.003
Strict	2,268.07	283	0.068	0.923	0.059	0.008
GENDER INVARIANCE						
Males (n = 1,767)	1,089.51	118	0.068	0.939	0.029	–
Females (n = 1,232)	733,41	118	0.064	0.942	0.028	–
Configural	1,800.84	236	0.066	0.940	0.029	–
Metric	1,859.70	251	0.065	0.938	0.031	0.002
Scalar	1,926.50	266	0.064	0.936	0.031	0.002
Strict	1,966.38	283	0.063	0.935	0.035	0.001

Results are based on MG-CFA models performed over the four available samples (Overall and Online samples of Study 1 and Study 2).

TABLE 5 | Zero-order and partial correlations of MGSES dimensions with other scales related to gambling.

	SOGS	PGSI	ERR_BEL	SYMB_M	ECON_M	HEDO_M	RISK	IMPULS
***OVERALL* SAMPLE (*N* = 2,030)**								
Zero order correlations								
REG_SE	−0.55	−0.58	−0.56	−0.49	−0.38	−0.49	−0.54	−0.37
AV_SE	−0.43	−0.47	−0.54	−0.45	−0.35	−0.47	−0.47	−0.32
Partial correlations								
REG_SE	−0.39	−0.40	−0.27	−0.26	−0.19	−0.24	−0.33	−0.21
AV_SE	*−0.03*	−0.08	−0.23	−0.15	−0.11	−0.18	−0.12	−0.07
***ONLINE* SAMPLE (*N* = 1,000)**								
Zero order correlations								
REG_SE	−0.38	−0.43	−0.34	−0.36	−0.26	−0.21	−0.29	−0.21
AV_SE	−0.27	−0.32	−0.32	−0.31	−0.20	−0.23	−0.31	−0.19
Partial correlations								
REG_SE	−0.27	−0.31	−0.16	−0.20	−0.17	*−0.04*	−0.08	−0.10
AV_SE	*0.02*	*0.03*	−0.10	*−0.05*	*−0.00*	−0.12	−0.15	*−0.05*

REG_SE, Self-efficacy in self-regulating gaming behavior; AV_SE, Self-efficacy in avoiding gambling behavior; SOGS, South Oaks Gambling Screen total score; PGSI, Problem Gambling Severity Index total score; ERR_BEL, Gamblers erroneous beliefs; SYMB_M, Symbolic motives for gambling; ECON_M, Economic motives for gambling; HEDO_M, Hedonic motives for gambling; RISK, Risk Taking; IMPULS, Impulsiveness. Correlations were significant for $p < 0.05$, excepting those reported in italics. Partial correlation for REG_SE were computed controlling for AV_SE; Partial correlation for AV_SE were computed controlling for REG_SE.

TABLE 6 | Zero-order correlations and partial correlations (within parentheses) of MGSES dimensions with measures of gambling behaviors.

	***Overall* sample (*N* = 2,030)**		***Online* sample (*N* = 1,000)**	
Gambling behavior	**REG_SE**	**AV_SE**	**REG_SE**	**AV_SE**
Number of games played (past 12 months)	−0.26*** (−0.11***)	−0.26*** (−0.10***)	−0.28*** (−0.16***)	−0.22***(−0.03^{ns})
Number of games played (past 3 months)	−0.30*** (-0.09***)	−0.28*** (-0.09***)	−0.22***(-0.11***)	−0.19***(−0.04^{ns})
Single Games				
- Lotteries	−0.04^{ns} (0.05*)	−0.08*** (−0.09***)	−0.19***(−0.10**)	−0.16***(−0.03^{ns})
- Instant lottery	0.03^{ns} (0.04^{ns})	0.00^{ns} (-0.03^{ns})	0.05^{ns}(0.03^{ns})	0.03^{ns}(−0.01^{ns})
- Bingo	−0.12*** (−0.05*)	−0.12*** (−0.04^{ns})	−0.14***(−0.09**)	−0.12***(−0.01^{ns})
- Betting	−0.17*** (−0.08***)	−0.15*** (-0.05*)	−0.18***(−0.12***)	−0.13***(0.01^{ns})
- Slots/VLT	−0.30*** (−0.23***)	−0.20*** (0.03^{ns})	−0.27***(−0.18***)	−0.21***(−0.01^{ns})
- Playing in casinos	−0.11*** (−0.06***)	−0.10*** (−0.03^{ns})	−0.21***(−0.10**)	−0.19***(−0.05^{ns})
Amount of money spent in a single day	−0.40*** (−0.27***)	−0.32*** (−0.03^{ns})	−0.26***(−0.16***)	−0.21***(−0.01^{ns})
Average time per day spent playing	−0.41*** (−0.26***)	−0.33*** (−0.03^{ns})	−0.26***(−0.14***)	−0.22***(−0.04^{ns})
Having one or both parents who are or used to be excessive gamblers	−0.13*** (−0.09***)	−0.09*** (0.01^{ns})	−0.13***(-0.09**)	−0.10***(0.00^{ns})

*RE_SE, Self-efficacy in self-regulating gaming behavior; AV_SE, Self-efficacy in avoiding gambling behavior; ns, statistically non-significant; *$p < 0.05$; **$p < 0.01$ and ***$p < 0.001$. Partial correlation for REG_SE were computed controlling for AV_SE; Partial correlation for AV_SE were computed controlling for REG_SE.*

TABLE 7 | Hierarchical logistic regression results for the land-based and online samples.

	Overall sample (*N* = 2,030)			*Online* sample (*N* = 1,000)		
	B	**SE**	**OR**	**B**	**SE**	**OR**
BACKGROUND VARIABLES (STEP 1)						
Gender (base = male)	0.03	0.30	1.03	−0.13	0.22	0.88
Age (base = low)	−0.01	0.01	0.99	−0.01	0.01	0.99
Education Level (base = high)	0.26	0.17	1.29	0.09	0.15	1.09
Income (base = low)	0.04	0.05	1.04	0.00	0.05	1.00
VARIABLES RELATED TO GAMBLING (STEP 2)						
ERR_BEL (base = low)	0.14	0.12	1.15	0.40***	0.10	1.49
SYMB_M (base = low)	0.09	0.18	1.09	−0.21	0.16	0.81
ECON_M (base = low)	−0.23	0.18	0.80	−0.09	0.15	0.91
HEDO_M (base = low)	1.18***	0.22	3.26	0.35*	0.16	1.42
RISK (base = low)	0.25*	0.13	1.28	0.05**	0.01	1.05
IMPULS (base = low)	0.02	0.03	1.02	0.06**	0.02	1.06
FAMIL (base = no)	1.60***	0.45	4.96	1.47***	0.25	4.34
REG_SE (base = high)	1.26***	0.24	3.54	1.34***	0.18	3.82
AV_SE (base = high)	0.37	0.24	1.45	0.28	0.17	0.76
	Step 1			**Step 1**		
χ^2(df)	9.82(4), $p = 0.044$			7.80(4), $p = 0.099$		
Hosmer and Lemershow test	$\chi^2(df = 8) = 13.46$, $p = 0.097$			$\chi^2(df = 8) = 7.10$, $p = 0.525$		
Nagelkerke R^2	1.5%			1.2%		
Classification accuracy	94.9%			79.2%		
	Step 2			**Step 2**		
χ^2(df)	416.26(13), $p < 0.001$			353.24(13), $p < 0.001$		
Hosmer and Lemershow test	χ^2(df = 8) = 8.35, $p = 0.400$			χ^2(df = 8) = 8.35, $p = 0.400$		
Nagelkerke R^2	57.9%			46.5%		
Classification accuracy	96.4%			84.2%		

*Dependent Variable, Gambling Severity Classification (0 = non-problematic gambler, 1 = at risk or problematic gamblers). B, Logistic regression coefficient; SE, Standard error of the logistic regression coefficient; OR, Odds Ratio; C.I., Confidence interval; ERR_BEL, Gamblers erroneous beliefs; SYMB_M, Symbolic motives for gambling; ECON_M, Economic motives for gambling; HEDO_M, Hedonic motives for gambling; RISK, Risk Taking; IMPULS, Impulsiveness; FAMIL, Having one or both parents who are or used to be excessive gamblers; REG_SE, Self-efficacy in self-regulating gaming behavior; AV_SE, Self-efficacy in avoiding gambling behavior; *p < 0.05, **p < 0.01 and ***p < 0.001.*

Discussion

The positive psychometric properties of the MGSES were fully supported by results of this second study. The two-factor structure was replicated completely in two independent samples, and factorial invariance across two conditions was also supported. The 17-item MGSES proved to be a valid and reliable measure for the assessment of self-efficacy beliefs in the domain of gambling behavior.

Correlations and logistic regressions proved the criterion validity of the scale, demonstrating a coherent pattern of correlations with the criteria under study. Specifically, while both MGSES dimensions were negatively associated with various constructs and behaviors related to gambling, REG_SE—rather than AV_SE—was most significant in protecting an individual from excessive gambling behavior and, thus, resulted in a higher unique negative association with problem gambling indicators. This result appears particularly relevant considering the stress that has been placed, in the literature, on the ability to restrain or to avoid gambling. In fact, our results show clearly that it is not avoidance or a generic ability to control one's own behavior that really matters as a protective factor for problem gambling; what matters, rather, is the capability of self-regulation and self-control through specific gaming behaviors, such as spending only the amount of money that one initially decides to spend, ceasing to play when one's predetermined time limit has been reached, avoiding spending money on gambling that is needed for other expenses, and ceasing to play after losing a game. This result is further supported by the logistic regression analyses, which highlighted the fact that REG_SE additionally contributed to explaining the dependent variable of problem gambling (obtained by a combination of SOGS and PGSI) above and beyond the impact of all other variables.

In line with our expectations and with the literature (e.g., Bandura, 2007), REG_SE has proven to be particularly relevant when considering problem gambling, as suggested by odds ratios. The more gamblers perceive themselves as capable of controlling their gambling behavior, the less they exhibit behaviors that are indicative of excessive problem gambling. The greater explicative power of the REG_SE over AV_SE is in line with Bandura's theorization (Bandura, 1997).

GENERAL DISCUSSION

This paper presented two independent studies, the results of which showed a clear convergence in supporting the psychometric properties of a new measure of self-efficacy within the domain of problem gambling: the MGSEG. An analysis of the literature on the role of self-efficacy in relation to gambling and gambling problems indicated that, although several studies have contributed to our knowledge of the role of self-efficacy in relation to gambling, these contributions were focused on the perceived ability to avoid gambling or restrain oneself from it. The self-regulation of gambling behavior was largely unexplored. The new self-efficacy scale, whose properties and characteristics are discussed here, provides a contribution aimed at filling this gap.

Through four different factor analyses on four independent samples of gamblers, the bi-dimensionality of the scale was demonstrated. The analyses supported the two posited dimensions and provided evidence for their high internal coherence. These dimensions refer to gamblers' beliefs about their capabilities regarding two factors: (a) self-regulating gambling behavior (REG_SE) and (b) avoiding risky gambling behavior (AV_SE). The importance of distinguishing between these two dimensions is attested by the findings from partial correlations with different measures of individual differences related directly or indirectly to gambling and with different behaviors regarded as markers of excessive gambling. Based on logistic regression, the two self-efficacy factors were considered, along with other factors, as independent variables, and problem gambling was considered as a dependent variable. In these analyses, the REG_SE dimension demonstrated a greater explicative power than the AV_SE dimension; moreover, REG_SE proved to be the stronger variable in explaining problem gambling, with the sole exception of familiarity.

This result is in line with SCT, which emphasizes the role of self-regulatory processes in the execution and modulation of behavior oriented toward the avoidance of negative consequences (e.g., Bandura, 1997, 2007). Gamblers who perceive themselves as more capable of regulating their own gaming behavior in order to realize a *positive* approach to gambling engage less frequently in excessive gambling. They spend less money for gamble, dedicate less time to gambling, and are less likely to be problem gamblers. Although the two factors of self-efficacy are highly correlated, they are also different. Their discriminant validity is not only proved by CFA, where the model assuming a single factor underlying the 17 items resulted in a much worse fit with respect to the two-factor target model, but also by the results of partial correlation and regression analyses. It is indeed important to measure these two different aspects of self-efficacy with respect to gambling: while the avoidance factor may plausibly be important and relevant in the evaluation of effectiveness of treatment, the regulative factor proves to be relevant (as evidenced by our findings) as far as responsible gaming behavior is concerned, and then mostly in a prevention context. Certainly, while the two factors are rooted in common self-regulative processes, they are not reducible to a single and general dimension.

Limitations and Future Studies

Since the data used in the studies came from four representative samples, we must acknowledge that these data are of a cross-sectional nature. Accordingly, any claim regarding the predictive value of the self-efficacy dimensions must be made with great caution. Future longitudinal studies may address more solidly the paths of association among self-efficacy and the indicators of gambling behavior and problem gambling, as well as the test-retest reliability of the two scales. The studies used in this paper were conducted in a single country, and this may affect the generalizability of the results to other cultural contexts. Again, future studies are needed to further investigate both the psychometric properties of the scales as well as their correlation with problem gambling in national contexts other than Italy.

Practical Implications

The results from the two studies discussed here suggest some practical implications. The bi-faceted structure of MGSES appears consistent with a view of excessive gambling that is not limited to a focus on avoidance but, rather, takes into account other capabilities more relevant to *positive* gambling. As noted above, the MGSES may be used for a variety of purposes. In the prevention of excessive gambling and in the promotion of responsible gambling, the REG_SE scale may provide a useful tool for gathering relevant information that a gambler may use in self-assessment of his or her own gaming behavior in order to understand how this behavior may be adjusted or modulated to avoid the occurrence of excessive and unregulated gambling. For this purpose, it would be particularly useful to integrate this scale with measures of problem gambling (such as the short PGSI scale) that may allow evaluation, in a broader sense, of whether gamblers perceive themselves as able to manage their gambling behavior. The AV_SE scale may prove useful in assessing the progress of the problematic or pathological gambler in the various stages of the treatment process for pathological/excessive gambling as well as his or her ability to avoid relapses. In this regard, it would be useful to complement this scale with measures of self-efficacy related to other domains wherein the individual may exert his/her agency, such as self-regulation of emotions and self-regulation in resisting peer pressure to engage in harmful behaviors. Individuals' capability in these domains is crucial in fostering adaptive behaviors and avoiding maladaptive behaviors (Bandura et al., 2003). Moreover, in their recent review of the literature on self-efficacy in the treatment of substance-use disorders, Kadden and Litt (2011) not only indicated the positive relations among self-efficacy and treatment outcomes but claimed that effective treatment should improve patients' capacity to recognize their improved ability to cope with situations that present temptation to indulge in the addictive behavior at hand. The use of MGSES could be particularly useful in this regard for delivering feedback regarding patients' performance (in controlling and/or avoiding their gambling behavior) and comparing it with their past performance, both in real-life situations and in skill-training homework practice exercises as defined by the therapist.

AUTHOR CONTRIBUTIONS

CB contributed on all sections of the paper. In particular he took care of the theoretical framework, to the literature review, to the methods, to discussion and conclusion, and to the definition of the data analytical strategy. VG contribute mainly to the data analysis, and to the writing of the results section. MV and RF contribute added their contribution to the writing of the methods, the results and the discussion sections.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg.2017.01025/full#supplementary-material

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Distorted Beliefs about Luck and Skill and Their Relation to Gambling Problems and Gambling Behavior in Dutch Gamblers

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Gamblers' cognitive distortions are thought to be an important mechanism involved in the development and maintenance of problem gambling. The Gambling Cognitions Inventory (GCI) evaluates two categories of distortions: beliefs that one is lucky (i.e., "Luck/Chance") and beliefs that one has special gambling-related skills (i.e., "Skill/Attitude"). Prior psychometric evaluations of the GCI demonstrated the utility of both subscales as measures of distortions and their concurrent relations to gambling *problems* among Canadian gamblers. However, these associations have not yet been studied in gamblers from other cultures nor have relationships between the GCI and indices of gambling *behavior* been investigated. In addition, the predictive validity of the GCI scales have not been evaluated in studies to date. The present study investigated the validity of the GCI as a measure of cognitive distortions in a sample of 49 Dutch gamblers by examining its concurrent and prospective relationships to both gambling *problems* (as measured through a standardized nine-item questionnaire assessing gambling-related problems) and *behaviors* (as measured through two variables: days spent gambling and time spent gambling in minutes) at baseline and over 1-month and 6-month intervals. The GCI subscales were internally consistent at all timepoints, and moderately to strongly inter-correlated at all timepoints. Each subscale correlated with an independent dimension of gambling both concurrently and prospectively: Luck/Chance was related to greater gambling *problems* and Skill/Attitude was related to greater gambling *behavior*. Thus, the two GCI subscales, while inter-correlated, appear to be related to different gambling outcomes, at least among Dutch gamblers. Moreover, the first evidence of the predictive validity of the GCI scales was demonstrated over a 1-month and 6-month interval. It is recommended that both types of cognitive distortions be considered in research and clinical practice to fully understand and address individual risk for excessive and problematic gambling.

Keywords: cognitive distortions, gambling behavior, gambling problems, luck, skill, measurement

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INTRODUCTION

Problem gambling is an important public health concern in many countries. In North America, 3.8% of individuals will experience symptoms of problem gambling within their lifetime, while 1.8% will exhibit more severe symptoms of past year gambling disorder (Jacques et al., 2000). Specifically in Canada and the United States, past year prevalence rates of problem gambling averaged 1.8 and 3.2%, respectively (Williams et al., 2012). Those in European countries experience similar levels of gambling problems to those in North America, with 2.0–3.5% exhibiting symptoms of problem gambling and 1.2–3.2% displaying more severe symptoms of a gambling disorder (Becona, 1996). Past year gambling rates differ between European countries, however, ranging from 0.5% in Netherlands and Denmark to 2.8% in Belgium (Williams et al., 2012). Gambling often results in financial losses for gamblers. In Canada, for example, the industry acquires a yearly average of approximately $237 per capita compared to $372 per capita in the United States and €51.76 per capita in Netherlands (Global Betting and Gaming Consultants, 2002). In addition to financial losses, disordered gambling creates adverse familial, societal, and psychological consequences. Such consequences underscore the importance of further investigation into its underlying mechanisms. Though many hypothesized pathways to a gambling problem exist, cognitive distortions are thought to be an important mechanism involved in the development and maintenance of problem and disordered gambling (Ladouceur and Walker, 1996).

Cognitive Distortions

Gambling-related cognitive distortions are central to the cognitive theory of gambling disorder. The cognitive theory of gambling disorder posits that cognitive distortions, also referred to as erroneous beliefs or fallacies, are involved in the development of, and serve to maintain, problem gambling (Ladouceur and Walker, 1996; Ladouceur, 2004). Broadly, these cognitive distortions are a set of false or exaggerated underlying beliefs that influence the automatic thoughts and behaviors a gambler experiences or displays during a gambling session (Ladouceur and Walker, 1996). These beliefs are thought to arise from the gambler's misperception of randomness, prompting the individual to believe he or she can exert control over and correctly predict the outcome of a chance-determined game. Motivated by the opportunity for monetary gain, the gambler's cognitive distortions prompt strategizing around the development of his or her gambling-related skill in an attempt to increase the likelihood of winning. The cognitive theory of problem gambling emphasizes that these faulty beliefs perpetuate gambling disorder by impacting the gambler's understanding of randomness, perceived control over the game, attributions of skill, motives for continued engagement in gambling, and perceived reasons for gambling losses (Breen et al., 2001).

The Gambling Cognitions Inventory

In a Canadian study, Holub (2003) developed a 40-item measure of gambling-related cognitive distortions called the Gambling Cognitions Inventory (GCI). McInnes et al. (2014) validated the GCI as a measure of gambling-related cognitive distortions in four different samples of Canadian problem and disordered gamblers. Confirmatory factor analysis confirmed a two-factor structure–beliefs one has special gambling-related skills (i.e., Skill/Attitude factor) and beliefs one is lucky (i.e., Luck/Chance factor). Each factor exhibited good internal reliability, with alphas ranging from 0.86 to 0.92 for the Skill/Attitude subscale and 0.83 to 0.90 for the Luck/Chance subscale. Moreover, the GCI showed good convergent validity with other measures of gambling distortions and with measures of gambling problems.

noted the two factors of the GCI closely mimic two of the most commonly studied fallacies in the gambling literature, the Illusion of Control (i.e., belief that one can control the outcome of a chance-determined game; Langer, 1975) for Skill/Attitude and the Gambler's Fallacy (i.e., belief that frequent losses will be followed by an imminent win; Toneatto, 1999) for Luck/Chance. Moreover, McInnes et al. (2014) note the GCI is unlike other measures of distortions in one important respect. As opposed to other measures of gambling-related cognitive distortions, which often assess both gambling-related distortions and other types of gambling-related cognitions, the GCI specifically assesses gambling-related cognitive distortions. For example, along with assessing gambling-related cognitive distortions, the Gambling Related Cognitions Scale also measures gambling expectancies (e.g., "gambling makes things seem better") and the gambler's perceived capacity to stop gambling (e.g., "I can't function without gambling"; Raylu and Oei, 2004a, p. 768).

The Importance of Examining Gambling *Problems* and Gambling *Behaviors*

In their study, McInnes et al. (2014) found both types of cognitive distortions (i.e., Luck/Chance and Skill/Attitude), as indexed by the GCI scales, were related to severity of gambling *problems*. However, akin to other addictive behaviors, the importance of examining both *problems* and *behaviors* as distinct outcomes has been well established. Sadava (1985) found alcohol consumption behavior and alcohol-related problems were only moderately correlated constructs (r's = 0.08–0.50), suggesting behaviors and problems are overlapping yet unique alcohol outcome dimensions. Moreover, certain variables independently relate to alcohol use *behaviors* and alcohol-related *problems*. For example, Stewart et al. (2006) found social anxiety (i.e., an intense fear of embarrassment or negative evaluation in social situations resulting in an avoidance of such situations; American Psychiatric Association, 2013) was positively related to drinking *problems*, yet negatively related to drinking *behavior*. In other words, socially anxious individuals seldom drink but when they do drink, they are likely to experience alcohol-related problems (Stewart et al., 2006). This finding demonstrates that drinking problems and drinking behavior are distinct and should be studied as such.

Like alcohol, disordered gambling is best understood by examining the underlying gambling behaviors that engender gambling problems (Walker et al., 2006). Examining gambling behaviors is relevant to understanding disordered gambling—targeting gambling behaviors in treatment often resolves

gambling problems. Akin to the alcohol literature, though inextricably linked, gambling behaviors (e.g., gambling frequency, time spent gambling, money spent gambling) and gambling-related problems (i.e., negative outcomes from gambling such as financial and relationship problems) are moderately, but not highly, inter-correlated (*r*'s = 0.34–0.61; Joukhador et al., 2004; Fischer and Smith, 2008; Flack and Morris, 2015). Although these two dimensions of gambling show some overlap, they are distinct, thus meriting an independent investigation of each dimension to fully comprehend the nature of disordered gambling. For example, Fischer and Smith (2008) examined the differential relationship of several impulsivity-related constructs to gambling *behavior* and gambling *problems*. The impulsivity constructs examined included "urgency" (i.e., the propensity to behave impulsively when upset) and "sensation seeking" (i.e., the propensity to pursue experiences that are novel or stimulating; Whiteside and Lynam, 2001). Although gambling *behavior* (as measured by gambling frequency) and gambling *problems* [as measured by the South Oakes Gambling Screen (SOGS); Lesieur and Blume, 1987] were moderately inter-correlated (r = 0.34), urgency was positively correlated solely with gambling *problems* while sensation seeking was positively correlated solely with gambling *behavior*. Evidently, examining either gambling problems *or* gambling behaviors alone does not paint a complete picture of disordered gambling. Given these findings, it is important to include measures of gambling *behavior* in addition to measures of gambling *problems* as outcome variables when examining the validity of any measure of gambling-related cognitive distortions.

Cognitive Distortions and Gambling *Problems*

Gambling-related cognitive distortions have been consistently found to be related to gambling *problems*. Previous literature has found a positive relationship between gambling-related cognitive distortions and problem gambling severity, where those with a greater severity of gambling problems endorse significantly more cognitive distortions compared to those with less severe gambling problems (Cunningham et al., 2014). For example, disordered gamblers and problem gamblers endorse considerably more cognitive distortions compared to both non-problem and social gamblers (Toneatto, 1999; Joukhador et al., 2004; Myrseth et al., 2010), even after controlling for genetic and environmental factors (Xian et al., 2009). While it is evident that gambling-related cognitive distortions and gambling problems are related, far less research examines the relation of gambling-related cognitive distortions to gambling behaviors.

Cognitive Distortions and Gambling *Behaviors*

A few studies have established a relationship between gambling-related cognitive distortions and gambling behaviors. In a sample of machine gamblers, for example, Joukhador et al. (2004) found those with greater superstitious beliefs around gambling spent more time gambling and engaged in more gambling sessions each week compared to those with less superstitious beliefs. Using data from five gambling prevalence studies, Miller and Currie (2008) examined the relationship between gambling-related cognitive distortions and risky gambling behaviors (i.e., borrowing money to gamble, returning to gamble to recoup prior losses, and betting more money than one can afford) in 11,652 Canadian gamblers. They found that gambling-related cognitive distortions and risky gambling behaviors were positively related. Specifically, those who endorsed a higher degree of gambling-related cognitive distortions engaged in significantly more risky gambling behaviors than those who endorsed a lesser degree of cognitive distortions. Yakovenko et al. (2016) sought to assess the temporal directionality of the relationship between cognitive distortions and gambling behaviors (i.e., gambling frequency, money spent, number of games played). They recruited 1,372 participants with varying degrees of gambling severity (i.e., 1,288 non-gamblers, 43 low-risk gamblers, 41 disordered gamblers) and found distortions, as indexed by the Gambling Fallacies Scale (Williams, 2003, Unpublished), predicted increases in gambling behaviors over time. In sum, to understand how cognitive distortions contribute to the development and maintenance of disordered gambling, we must elucidate their relationship to both gambling problems and gambling behaviors.

Cultural Differences in Gambling Distortions

While these studies further our understanding of the role of cognitive distortions in gambling-related problems and behaviors, this body of empirical research has been predominantly performed with North American samples (Raylu and Oei, 2004b). Varying values and beliefs across cultures may be reflected in varying gambling-related cognitive distortions across cultures, in turn contributing to cultural differences in gambling behaviors and levels of gambling problems (Raylu and Oei, 2004b).

Gambling is defined differently across cultures (Dickins and Thomas, 2016). In their review of the literature, Dickins and Thomas (2016) note that the definition of gambling is molded by the collective attitude, acquired through cultural customs. These alternative definitions of gambling result in certain gambling practices being viewed as acceptable in some cultures yet unacceptable in others. Accompanying these cultural beliefs are various risk and protective factors that help prompt or protect against disordered gambling, with these influences potentially varying across cultures (Oei and Goh, 2015). For example, self-perceived resilience has been linked to greater gambling problems among Chinese gamblers who endorse greater gambling-related cognitive distortions (Oei and Goh, 2015) yet less severe gambling problems in Canadian gamblers (Lussier et al., 2007). It has been speculated that cultural beliefs which favor gambling, such as those based on superstition, fate, luck, and chance, might contribute to cross-cultural differences in disordered gambling by means of encouraging and normalizing gambling involvement (Raylu and Oei, 2004b; Papineau, 2005; Oei and Goh, 2015). While beliefs in luck and chance are present in most cultures, some cultures hold more profound beliefs in superstition, fate, luck, and chance, which are presumably derived from cultural customs such as religion (Dickins and Thomas, 2016). Among other things, these beliefs are thought to extend to a given

culture's gambling practices (Raylu and Oei, 2004b; Papineau, 2005).

Members of the Chinese culture have shown profound beliefs in superstition, fate, luck, and chance (Raylu and Oei, 2004b; Papineau, 2005). Lam (2007) performed a naturalistic study which involved observing the gambling behaviors of Chinese baccarat players at a casino in Macau. He reported witnessing high levels of the illusion of control, inferred when players were observed shouting out specific words or phrases in hopes of influencing the chance of obtaining a smaller or larger numbered card. Ohtsuka and Chan (2010) examined the superstitious beliefs of Chinese problem and non-problem mahjong gamblers using self-report questionnaires. Although both gambler types reported superstitious beliefs, problem gamblers endorsed significantly more cognitive distortions regarding mahjong than non-problem gamblers. Compared to cultures in which beliefs in luck and chance are not as profound, members of the Chinese culture have shown greater beliefs specifically in the illusion of control compared to those of Caucasian decent (Oei et al., 2008). However, this is not always the case, and while superstitious beliefs can differ between cultures, certain beliefs may also be shared. For example, American and Chinese gamblers have been found to hold similarly strong superstitious beliefs regarding gambling rituals compared to Japanese and Korean gamblers, who do not tend to endorse this type of superstitious thinking (Kim et al., 2016).

Additional evidence of cultural differences in disordered gambling comes from differing prevalence rates of problem gambling between cultures. Differences in prevalence rates of disordered gambling are observed for many cultures, but also among those where beliefs in superstition, fate, luck, and chance are not as insidious and profound. In Netherlands, although 87% of individuals have reported gambling in their lifetime, only a small proportion exhibit gambling-related problems (De Bruin et al., 2006, as cited in Goudriaan et al., 2009). Approximately 1.0% of individuals 16 years of age and older are considered to have a lifetime gambling disorder in Netherlands; yearly prevalence rates of problem gambling are approximately 0.5%. This is similar to past year disordered gambling rates in nearby European countries such as Denmark (0.5%) yet comparatively lower than past year disordered gambling rates in Canada (1.2–2.2%) and the United States (1.7–4.6%; Williams et al., 2012).

While cultural customs and traditions may influence gambling practices, additional variables to be considered are the structural barriers imposed by laws which limit accessibility to gambling activities (Jacques et al., 2000; Raylu and Oei, 2004b). Different gambling laws and regulations within a particular culture may impact an individual's values and beliefs around gambling (Raylu and Oei, 2004b). Certain gambling-related policies in Netherlands may contribute to the relatively lower disordered gambling rate compared to other countries such as Canada and the United States (De Bruin et al., 2001, as cited in Goudriaan et al., 2009). Since the year 2000 when stricter gambling laws were imposed, the number of slot machines in Netherlands has decreased. A primary goal from these more restrictive laws was to reduce "automatic," persistent gambling behavior (De Bruin et al., 2001, as cited in Goudriaan et al., 2009, p. 191). As a part of these regulations, slot machines not currently in use were no longer permitted to display flashing lights or sounds, limiting their appeal to the potential user. Slot machines were no longer permitted in certain types of entertainment establishments such as bowling alleys and sports clubs, but continued to be allowed in pubs and restaurants, with these latter establishments limited to two slot machines each. Employees at gambling establishments received education on disordered gambling, including how to approach those who appeared to have a gambling problem or displayed problematic gambling behavior. Moreover, gamblers could voluntarily prohibit their own entry into certain gambling establishments (De Bruin et al., 2001, as cited in Goudriaan et al., 2009). However, the strict policies in 2000 do not necessarily apply to online gambling, which has become increasingly popular, forcing the privatization of the gambling industry and the liberalization of the gambling market since 2002 (Kingma, 2008).

Thus, while many individuals in Netherlands engage in gambling, a relatively lower proportion develop gambling problems relative to those in many other parts of Europe and in North America (De Bruin et al., 2006, as cited in Goudriaan et al., 2009). It is curious whether established risk factors such as cognitive distortions operate similarly in Dutch culture as in North America, where rates of problem gambling are relatively higher. However, it is difficult to assess whether certain gambling policies, such as those in Netherlands, create cross-cultural differences in gambling-related cognitive distortions. This is because many instruments assessing gambling-related cognitions are developed with, and validated on, North American gamblers. This calls into question the ability to generalize findings with these existing cognitive distortion measures to other cultures where values and beliefs may differ from those of mainstream North America.

The Present Study

While the GCI has been validated in a large sample of Canadian gamblers, it has yet to be validated as a measure of distortions in other cultures. Further, while the relationship of the GCI subscales to gambling *problems* has been demonstrated (McInnes et al., 2014), the relation of GCI distortions to gambling *behaviors* has yet to be established. Additionally, the predictive validity of the GCI has yet to be determined. Thus, the purposes of the present study were to examine the concurrent and prospective relationships of the GCI scales to gambling *behaviors* and *problems* at baseline and over 1-month and 6-month follow-ups in a sample of Dutch gamblers. It was hypothesized that both Luck/Chance and Skill/Attitude distortions would be concurrently positively associated with both gambling *behaviors* and gambling-related *problems*. Moreover, it was hypothesized that baseline values on these two GCI subscales would be positively associated with gambling-related *behaviors* and *problems* 1-month and 6-months later. Findings different than those observed in North American gamblers (McInnes et al., 2014) in a sample of Dutch gamblers could broaden our understanding of the impact of cultural beliefs on gambling *behavior* and *problems* and elucidate whether established risk

factors and correlates, in this case cognitive distortions, operate differently across cultures.

MATERIALS AND METHODS

Participants

Participants were community-recruited through online gambling forums[1,2], social media sites (i.e., Facebook and Twitter) and advertisements placed throughout the city of Amsterdam. To be eligible, participants were required to be 18 years of age or older, not attempting to abstain from gambling, and have gambled online or at a casino at least three times in the past 2 months (not including lottery tickets). Moreover, respondents were required to complete the study from distinct IP addresses to be eligible. This was to help eliminate any opportunities for fraud (i.e., a single participant completing the study more than once). Fifty-three participants were originally recruited. Four participants were excluded, one due to unfulfilled inclusion criteria and three due to repeat IP address issues and concerns about potential fraudulent data. The final sample was composed of 49 participants (all male) at baseline, 46 at the 1-month follow-up, and 41 at the 6-month follow-up (see **Table 1** for distribution of gambling risk). Our sample was primarily composed of low to moderate risk gamblers (see **Table 1**). At baseline, one participant completed only week one of the Gambling Timeline Followback (G-TLFB; Sobell and Sobell, 1992; Weinstock et al., 2004) and thus, this participant's data was considered incomplete at this timepoint. Additionally, one participant solely entered data for the days in which they gambled at baseline but no other variable. Thus, for the G-TLFB at baseline, 48 participants have complete data for days gambled and 47 have complete data for time spent gambling. At the 1-month follow-up, two participants failed to complete the GCI and thus for this measure, there were 44 participants. At baseline, participants ranged in age from 20 to 59 years old (M = 30.8, SD = 9.0). Once eligible, participants completed Dutch translations of the following questionnaires: the Problem Gambling Severity Index (PGSI) of the Canadian Problem Gambling Index (CPGI; Ferris and Wynne, 2001; McCready and Adlaf, 2006) which assessed level of gambling problems, the GCI (Holub, 2003; McInnes et al., 2014) to assess gambling-related cognitive distortions, the 30-day G-TLFB (Sobell and Sobell, 1992; Weinstock et al., 2004) to assess gambling behavior, and the first question of the South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987) to describe the types of gambling games played by participants.

[1]http://Voetbalweddenschappen.com

[2]http://onlinegokforum.nl

Measures

Translation of Measures

Dutch translations of the SOGS and PGSI were used in the present study. The GCI was translated from English to Dutch and then back-translated from Dutch to English by two independent research associates. The first individual was a native Dutch speaker who was fluent in English and familiar with the contents of the GCI and the second individual was a native (American) English speaker who was also fluent in Dutch. The comparison of the back-translated version of the GCI to the original English version was acceptable and required only minor revisions in phrasing. A research associate also translated the G-TLFB from English to Dutch. The G-TLFB did not require any back-translation procedure as it is very simple and explicitly asks specific questions.

Severity of Gambling-Related Problems

The PGSI of the CPGI was administered to determine participant's severity of gambling problems. This measure is composed of nine items (e.g., "How often have you bet more than you could really afford to lose?"; "How often has your gambling caused you any health problems, including stress or anxiety?"). Each question is rated on a 4-point Likert scale with responses being 0 (*never*), 1 (*sometimes*), 2 (*most of the time*), and 3 (*almost always*). All nine items are summed with higher scores indicating greater gambling-related problems (Currie et al., 2013). This summed score creates four categories of gambling-related risk: non-problem gambling (score of 0), low levels of gambling problems (score of 1 or 2), moderate levels of gambling problems (score of 3–7), and problem gambling (score of 8 or more; Ferris and Wynne, 2001). The PGSI has demonstrated good internal consistency (α = 0.84; Ferris and Wynne, 2001) and test–retest reliability over a 3- to 4-week period (r = 0.78). It has also shown good convergent validity with the SOGS and *DSM-IV* criteria for pathological gambling (American Psychiatric Association, 1994; Ferris and Wynne, 2001). In the present study, the PGSI demonstrated acceptable internal consistency at baseline (α = 0.74) and 6-months (α = 0.74), and marginally acceptable internal consistency at 1-month (α = 0.66). Moreover, it demonstrated good test–retest reliability over 1-month [$r(46) = 0.73$, $p < 0.001$] and 6-months [$r(41) = 0.65$; $p < 0.001$] in the present study.

TABLE 1 | Distribution of gambling risk across baseline (T1), 1-month (T2), and 6-months (T3).

	Non-problem gambler		Low levels of problems		Moderate levels of problems		Problem gambler	
	n	%	*n*	%	*n*	%	*n*	%
T1	8	16.3	18	36.7	18	36.7	5	10.2
T2	9	19.6	14	30.4	21	45.7	2	4.3
T3	9	22.0	16	39.0	13	31.7	3	7.3

Gambling-Related Cognitive Distortions

The original GCI is a 40-item measure that assesses gambling-related cognitive distortions regarding Luck/Chance and Skill/Attitude (Holub, 2003; McInnes et al., 2014). Each item is rated on a 4-point Likert scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*). Items were reverse scored so that higher scores indicate higher levels of given cognitive distortions. In the present study, we administered the 40-item version but scored the measure based on the refined 33-item version which is embedded within the original (McInnes et al., 2014). The refined version has 14 items for the Luck/Chance subscale and 19 items for the Skill/Attitude subscale. An example of a question related to Luck/Chance cognitive distortions is: "I can tell when I am lucky or am having a lucky day, and that is a good day to gamble." An example of a question assessing cognitive distortions related to Skill/Attitude is: "I can analyze my wins to give me strategies to make me a better gambler." To score the subscales of the 33-item GCI, items are first converted from a 1–4 to a 0–3 scale; then items pertaining to each subscale are summed and divided by the maximal possible summed score to obtain a score between 0 and 1. A score closer to 1 indicates greater cognitive distortions while a score closer to 0 indicates less cognitive distortions. To score the Luck/Chance subscale, each of the relevant 14 items were summed; this sum was then divided by 42 (the maximum possible Luck/Chance sum). To score the Skill/Attitude subscale, each of the 19 items was summed; this sum was then divided by 57 (the maximum possible Skill/Attitude sum). The Luck/Chance and Skill/Attitude subscales have shown marginally acceptable to good internal reliability ($\alpha = 0.67–0.87$) and good concurrent validity with the SOGS (r's = 0.41–0.43) and PGSI in Canadian samples (r's = 0.25–0.36; significant at $p < 0.05$; McInnes et al., 2014).

Gambling Behavior

The G-TLFB is a 30-day retrospective calendar that asks participants to reflect upon and report various gambling-related behaviors they have engaged in during the past month. The present study looked specifically at the following behaviors: number of days gambled and time spent gambling. Initially, money risked gambling was included as an outcome measure. However, this measure was poorly correlated, and often not correlated, with itself and the other G-TLFB items and thus was not included in the present study. Anecdotally, participants find money risked a hard concept to understand and the person administering the measure often needs to explain, with examples, what is meant by money risked. It is possible that in the online format, participants interpreted this item differently and this added measurement error and obscured any expected relations.

Participants were instructed to enter data on their gambling behavior for each day that they gambled. The G-TLFB exhibits good test–retest reliability over a 2-week period (r's = 0.74–0.96) and good concurrent validity with the SOGS (r's = 0.30–0.32; Lesieur and Blume, 1987; Weinstock et al., 2004). In the present study, days spent gambling showed good test–retest reliability over 1-month [$r(46) = 0.57$; $p < 0.001$] and 6-months [$r(41) = 0.43$; $p = 0.003$]. As well, time spent gambling showed good test–retest reliability over 1-month [$r(45) = 0.72$; $p < 0.001$] and 6-months [$r(41) = 0.36$; $p = 0.010$].

Frequency of Games Played

The first question of the SOGS was used for sample description purposes to assess the frequency with which participants engaged in certain types of gambling (Lesieur and Blume, 1987). Participants were asked to indicate the degree to which they have partaken in particular forms of gambling in their lifetime, with responses being "*not at all*," "*less than once a week*," and "*once a week or more.*"

Statistical Analysis

Pearson product moment correlations and Spearman's Rank correlations were performed in IBM SPSS Statistics (version 22) between the GCI subscales (i.e., Luck/Chance and Skill/Attitude) and gambling problem and behavior indices from the PGSI and G-TLFB, respectively. Pearson's correlations were followed with a test of differences in dependent correlations using Steiger's Z-test of parametric correlations. One-tailed tests were used, as directional predictions had been made *a priori*. Internal consistency estimates for each GCI subscale were also performed in SPSS by calculating Cronbach's alpha. Cohen's (1992) conventions were used to judge the magnitude of effect sizes for the correlations and the differences between correlations in the present study. Cohen's conventions are as follows: small ($0.10 < r < 0.30$); medium ($0.30 < r < 0.50$); large ($r < 0.50$).

Procedure

The present study was carried out in accordance with the recommendations of the University of Amsterdam and the Dalhousie University Research Ethics Boards with informed consent from all subjects. The protocol was approved by the University of Amsterdam and the Dalhousie University Research Ethics Boards. The participants completed the screening, informed consent, questionnaires, and debriefing online in their homes. Interested participants clicked on the link to the study website displayed on banners and advertisements. This link directed the participant to the study website where they created an account and completed eligibility screening. Once deemed eligible, participants were directed to a page detailing informed consent. As the study was performed online, informed consent involved checking boxes for statements that detailed the informed consent. Checking these boxes indicated that the participant understood each statement and that they made an informed decision to participate. All participants gave informed consent in accordance with the Declaration of Helsinki. Once the participant consented, they were invited to begin the study. The following questionnaires were administered at baseline: a demographics questionnaire, the PGSI of the CPGI, the GCI, the G-TLFB, and the first question of the SOGS for descriptive purposes. The following questionnaires were administered at the 1-month and 6-month follow-up: the PGSI of the CPGI, the GCI, and the G-TLFB. Each session (baseline, 1-month follow-up, and 6-month follow-up) lasted approximately 25 min and following its completion, the participant received a claim code for a €17.80 (∼$25.00 Canadian) Bol.com vouchers as remuneration.

All the questionnaires were completed online using the platform Qualtrics (Qualtrics, 2016).

RESULTS

Descriptive Statistics

Means, standard deviations, and ranges for measures of gambling problems, gambling behaviors (i.e., days spent gambling and time spent gambling in minutes), and gambling-related cognitive distortions (i.e., Luck/Chance and Skill/Attitude distortions) are available in **Table 2**. Values provided for the GCI subscales are based on the 0–1 rescaling of the measure.

In the present study, frequent playing of skills games (e.g., cards) was much more common than frequent playing of chance games (e.g., 98% played cards versus 14% played slot machines once a week or more), as indexed by the first item of the SOGS.

Psychometric Properties of the Gambling Cognitions Inventory

The Skill/Attitude and Luck/Chance subscale were moderately inter-correlated at baseline [$r(49) = 0.56$, $p < 0.001$] and 6-months [$r(41) = 0.57$, $p < 0.001$] and strongly inter-correlated at 1-month [$r(44) = 0.67$, $p < 0.001$]. The Skill/Attitude and Luck/Chance subscales also demonstrated good to excellent internal consistency at baseline (α's = 0.90 and 0.87, respectively), 1-month (α's = 0.89 and 0.93, respectively), and 6-months (α's = 0.94 and 0.92, respectively). Lastly, the test–retest reliability of the Luck/Chance subscale [$r(44) = 0.79$, $p < 0.001$] and Skill/Attitude subscale [$r(44) = 0.75$, $p = 0.001$] from baseline to 1-month follow-up were both significant, demonstrating strong stability over 1-month. At baseline to 6-months, the test–retest reliability of the Luck/Chance subscale [$r(41) = 0.73$, $p < 0.001$] and Skill/Attitude subscale [$r(41) = 0.77$, $p < 0.001$] were significant, demonstrating strong stability over 6-months.

Gambling Problems

Luck/Chance distortions were positively related to gambling problems at all timepoints (baseline, 1-month, and 6-months; see **Table 3**, left column) and these relations were medium (baseline and 6-months) and large (1-month) in magnitude.[3] Cognitive distortions regarding Skill/Attitude were unrelated to gambling problems at all three timepoints.

Steiger's *Z*-tests showed the correlation between Luck/Chance distortions and gambling problems was stronger than the correlation between Skill/Attitude distortions and gambling problems at baseline ($z = 3.02$, $p = 0.002$), 1-month ($z = 3.33$, $p < 0.001$), and 6-months ($z = 2.22$, $p = 0.026$). All effect sizes of these correlational differences were medium in magnitude.

Gambling Behavior

Days Spent Gambling

Baseline endorsement of Luck/Chance distortions were not concurrently related to days spent gambling at baseline nor were they prospectively associated with days spent gambling at 1-month (see **Table 3**, middle column). However, baseline Luck/Chance scores were positively related to days spent gambling at 6-months, and this effect size was moderate in magnitude. Skill/Attitude distortions were positively related to days spent gambling at all timepoints, being significantly related at baseline and 6-months and marginally related at 1-month. The effect sizes of these correlations were small at both baseline and 1-month but moderate at 6-months.

Steiger's *Z*-tests showed that the correlation between baseline Skill/Attitude distortions and days spent gambling was no stronger than the correlation between baseline Skill/Attitude distortions and gambling problems at baseline ($z = -1.30$, $p = 0.195$), 1-month ($z = -0.81$, $p = 0.419$), or 6-months ($z = -1.19$, $p = 0.236$). Moreover, the correlation between baseline Skill/Attitude distortions and days spent gambling was no stronger than the correlation between baseline Luck/Chance distortions and days spent gambling at baseline ($z = -1.40$, $p = 0.16$), 1-month ($z = -1.18$, $p = 0.24$), or 6-months ($z = -0.25$, $p = 0.81$). However, the correlation between baseline

[3]Given violations of assumptions of normality, Spearman's rank correlations were also performed for each variable at all timepoints. The pattern of findings were similar to those reported using Pearson correlations where Luck/Chance distortions were related to problems both concurrently and prospectively while distortions related to Skill/Attitude were related to behaviors both concurrently and prospectively, yet not problems.

TABLE 2 | Means, standard deviations, and ranges of Luck/Chance and Skill/Attitude Gambling Cognitions Inventory (GCI) subscales and outcome measures of gambling severity (PGSI) and behavior (G-TLFB) at baseline (T1), 1-month (T2), and 6-months (T3).

	T1				T2			T3		
	M	*SD*	Range		*M*	*SD*	Range	*M*	*SD*	Range
Variable			**Possible**	**Actual**			**Actual**			**Actual**
PGSI	3.12	2.83	0 – 27	0 – 11	2.89	2.46	0 – 10	2.76	2.82	0 – 12
G-TLFB										
Days	9.00	6.46	0 – 31	0 – 31	9.61	8.91	0 – 31	6.66	6.91	0 – 31
Time (min)	1,260.17	1,211.86	–	0 – 5,768	1,425.13	1,802.21	0 – 9,563	1,051.44	1,271.32	0 – 6,195
GCI										
Luck/Chance	0.15	0.15	0 – 1	0 – 0.57	0.23	0.21	0 – 0.71	0.21	0.20	0 – 0.81
Skill/Attitude	0.44	0.20	0 – 1	0 – 0.75	0.50	0.18	0 – 0.77	0.47	0.23	0 – 0.96

Luck/Chance and 1-month gambling problems was stronger than the correlation of baseline Luck/Chance with 1-month days spent gambling ($z = 2.10$, $p = 0.035$; compare **Table 3**, left and middle columns) and the effect size of this correlational difference was medium in magnitude.

Because baseline Luck/Chance distortions were related to both gambling problems and gambling behavior (days spent gambling) at 6-months, we also conducted *post hoc* partial correlations to examine possible unique relations of this form of distortion with gambling problems. *Post hoc* partial correlations revealed, when controlling for days spent gambling at 6-months, baseline Luck/Chance distortions continued to be positively related to 6-month PGSI scores ($r_{ab.c} = 0.39$, $p = 0.006$). However, the relationship between baseline Luck/Chance distortions and days spent gambling at 6-months was no longer significant when PGSI scores at 6-months were controlled in a *post hoc* partial correlation ($r_{ab.c} = 0.22$, $p = 0.084$).

Time Spent Gambling

Baseline Luck/Chance distortions were not related to time spent gambling at any timepoint (see **Table 3**, right column). Baseline Skill/Attitude distortions were concurrently, positively, related to time spent gambling at baseline and marginally, positively, related to time spent gambling at 6-months. These correlations were moderate and small in magnitude, respectively. Skill/Attitude distortions were not related to time spent gambling at 1-month.

Steiger's *Z*-tests showed the correlation between baseline Skill/Attitude distortions and time spent gambling was no stronger than the correlation between baseline Skill/Attitude distortions and gambling problems at baseline ($z = -1.67$, $p = 0.095$), 1-month ($z = -0.54$, $p = 0.593$), or 6-months ($z = -0.64$, $p = 0.521$). Moreover, the correlation between baseline Skill/Attitude distortions and time spent gambling was no stronger than the correlation between baseline Luck/Chance distortions and time spent gambling at baseline ($z = -1.08$, $p = 0.28$), 1-month ($z = -0.72$, $p = 0.47$), or 6-months ($z = -0.42$, $p = 0.68$). However, the correlation between baseline Luck/Chance and 1-month gambling problems was stronger than the correlation of baseline Luck/Chance with 1-month time spent gambling ($z = 2.16$, $p = 0.03$; compare **Table 3**, left and right columns) and the effect size of this difference was medium in magnitude.

Summary

Luck/Chance distortions were more strongly related to problems than to behaviors, with the differences in strength being medium in magnitude. Luck/Chance was also more strongly related to problems than was Skill/Attitude, with the effect size of this difference being medium in magnitude. Although Skill/Attitude distortions were related to gambling behaviors but not to gambling problems, skill distortions were not more strongly related to behaviors than they were to problems. Further, there was no evidence to suggest that Skill/Attitude distortions were more strongly related to gambling behaviors than were Luck/Chance distortions.

DISCUSSION

The present study investigated the validity of the GCI as a measure of cognitive distortions in a sample of Dutch gamblers. Moreover, it investigated the concurrent and prospective relationship of the GCI to gambling *problems* and *behaviors* at baseline and over 1-month and 6-months. The findings provide initial support for the cross-cultural validity of the measure in tapping aspects of gambling-related cognitive distortions that show important relationships to gambling outcomes. In a sample of Dutch gamblers, as baseline Luck/Chance distortions increased, so did concurrent gambling-related *problems*. Having greater cognitive distortions related to one's own luck were also associated with greater gambling-related problems 1- and 6-months later. These baseline Luck/Chance distortions were found to be uniquely associated with gambling-problems. While baseline luck distortions were also associated with a greater number of days spent gambling at the 6-month follow-up, this relation did not persist when 6-month gambling problems were

TABLE 3 | Pearson Product Moment Correlations between the Luck/Chance and Skill/Attitude Gambling Cognitions Inventory (GCI) Subscales at baseline (T1) with outcome measures of gambling severity (PGSI) and behavior (G-TLFB) at baseline (T1), 1-month (T2), and 6-months (T3).

	Outcome Variable		
T1 GCI Subscales	**PGSI**	**G-TLFB**	
Outcome wave		**Days**	**Time**
Luck/Chance			
T1 outcome	$r(49) = 0.43$, $p = 0.001$**	$r(48) = 0.10$, $p = 0.247$	$r(47) = 0.21$, $p = 0.076$
T2 outcome	$r(46) = 0.51$, $p < 0.001$***	$r(46) = 0.08$, $p = 0.310$	$r(46) = 0.08$, $p = 0.308$
T3 outcome	$r(41) = 0.44$, $p = 0.002$**	$r(41) = 0.31$, $p = 0.025$*	$r(41) = 0.18$, $p = 0.126$
Skill/Attitude			
T1 outcome	$r(49) = 0.03$, $p = 0.426$	$r(48) = 0.29$, $p = 0.023$*	$r(47) = 0.36$, $p = 0.007$*
T2 outcome	$r(46) = 0.06$, $p = 0.338$	$r(46) = 0.24$, $p = 0.053^{\dagger}$	$r(46) = 0.18$, $p = 0.118$
T3 outcome	$r(41) = 0.12$, $p = 0.229$	$r(41) = 0.34$, $p = 0.014$*	$r(41) = 0.25$, $p = 0.062^{\dagger}$

****p < 0.001, **p < 0.01, *p < 0.05. †Marginally significant. All one-tailed tests.*

controlled. In contrast, higher levels of baseline Skill/Attitude distortions were concurrently associated with a greater number of days spent gambling and increased time spent gambling. Believing one has greater gambling-related skill at baseline was significantly associated with greater days spent gambling at the 6-month follow up. Moreover, baseline skill beliefs were also marginally associated with days spent gambling at the 1-month follow-up, and with greater time spent gambling at the 6-month follow-up.

Our findings partially provide a cross-cultural replication of the GCI as being related to gambling problems in Dutch gamblers. Our observed relationship of Luck/Chance distortions to gambling problems is consistent with previous literature with Canadian gamblers, where increased Luck/Chance distortions were related to increased severity of gambling problems (McInnes et al., 2014). Similar to the present study, these effects were of moderate strength (McInnes et al., 2014). This finding also fits with the broader literature using other cognitive distortion measures that suggest a greater endorsement of gambling-related false beliefs is associated with a greater severity of gambling-related problems (e.g., Cunningham et al., 2014). Thus, we can conclude this aspect of McInnes et al.'s (2014) findings with Canadian gamblers appears to be generalizable to Dutch gamblers. However, we did not replicate McInnes et al.'s (2014) findings that Skill/Attitude distortions were concurrently associated with severity of gambling problems. In fact, in our Dutch sample, the relation between Luck/Chance distortions and gambling problems was significantly stronger than the relation between Skill/Attitude distortions and gambling problems – a difference of moderate magnitude. Moreover, the relationship between baseline Luck/Chance distortions and gambling problems at 6-months persisted even after controlling for days spent gambling at 6-months, suggesting these distortions are uniquely related to future gambling problems even after controlling for gambling behavior. These findings call for further research to determine what may underlie the relationship between gambling problems and distortions related to luck and how these distortions might put people at risk for gambling problems over-and-above putting them at risk for excessive gambling behaviors.

One possible reason why Luck/Chance distortions, but not Skill/Attitude distortions, were related to current and future gambling *problems* in the present study of Dutch gamblers pertains to the nature of our Dutch sample. While the entire sample of Canadian gamblers in McInnes et al. (2014) consisted of problem and disordered gamblers, the present Dutch study included non-problem as well as problem gamblers. Overall, the average severity of gambling problems in our sample was in the moderate risk range (mean PGSI score of approximately 3). It is possible that relations of Skill/Attitude distortions to gambling problems may only emerge at relatively higher levels of gambling problems, and perhaps the level of problems was not sufficiently high in our sample to reveal relations with Skill/Attitude distortions.

The present study extended the results found by McInnes et al. (2014) by examining the relations of GCI subscale scores to gambling *behaviors* – an outcome not previously examined in relation to GCI scores in any cultural group. The findings of the present study fit with the results of Joukhador et al. (2004) using an alternate measure of gambling-related cognitive distortions whereby among a sample of machine gamblers, those with greater gambling-related cognitive distortions spent more time gambling and participated in more gambling sessions each week compared to those with fewer cognitive distortions. While we found Skill/Attitude distortions were related to gambling behaviors and generally not to gambling problems, the correlation differences of Skill/Attitude distortions with gambling behaviors as the outcome were not significantly greater than the correlation of Skill/Attitude distortions with gambling problems. Nor were the correlations between Skill/Attitude distortions with gambling behaviors significantly greater than the correlation of Luck/Chance distortions with gambling behaviors. This may have been due to the small sample size and associated weak power to detect such correlational differences in the present study, as discussed further in the limitations section. While admittedly a less robust finding than the unique and moderate sized relationship of luck distortions to gambling problems, our correlational findings provide modest support for a relationship between skill distortions and increased gambling behaviors, a relationship not found for luck distortions. Baseline Luck/Chance distortions were unrelated to either gambling behavior at baseline or 1-month follow-up in our Dutch sample of gamblers. While baseline Luck/Chance distortions were related to days spent gambling at 6-months, *post hoc* analyses revealed this effect did not persist when gambling problems at 6-months were statistically controlled.

One possible reason why Skill/Attitude distortions, as opposed to Luck/Chance distortions, were predominantly related to gambling *behaviors* but not to gambling *problems* in our study pertains to the types of games favored by our sample of Dutch gamblers. It has been suggested that games of skill bring about persistent gambling *behavior* compared to games of luck (Dickerson, 1993). In fact, increasing an individual's perceived skill over a game has been shown to result in greater gambling *behavior* (Langer, 1975). Myrseth et al. (2010) found that gamblers who solely preferred games of skill evidenced greater illusion of control (similar to Skill/Attitude cognitive distortions) compared to those who solely preferred games of chance. Perhaps those who engage in more games of skill believe they have greater control over the game and thus perceive they have greater control over their gambling, resulting in greater gambling *behavior*. The Dutch gamblers in the present study were community-recruited through online websites, posters, and gambling forums. Particularly on gambling forums, gamblers discuss certain strategies or perceived skill related to gambling which may have caused a selection bias, resulting in the recruitment of those who predominantly played skill-based games. In support of this possibility, frequent playing of skill games (e.g., playing cards) once a week or more was much more common than frequent playing of chance games (e.g., playing slots) among the present study's gamblers (98% vs 14%, respectively).

However, it is important to emphasize that this explanation is speculative.

While it is plausible certain methodological and sampling differences may have brought about the differences between our study and the findings of McInnes et al. (2014), the divergences may be the result of a true cross-cultural difference in cognitive distortions and/or gambling practices. Unlike McInnes et al. (2014) Canadian study, we did not observe a relationship between Skill/Attitude distortions and *problems* in our Dutch sample. This does not indicate the GCI Skill/Attitude scale is an invalid measure of cognitive distortions in Dutch gamblers, as Skill/Attitude belief scores were related to gambling *behaviors*. Rather, it is possible that differences in gambling practices and policies ascribed by different cultures resulted in inherently different gamblers in Netherlands than those in Canada (Raylu and Oei, 2004b; Papineau, 2005; Oei et al., 2008). Perhaps distorted beliefs about skill are more important for the development and maintenance of gambling-related problems in Canadian as opposed to Dutch gamblers due to certain cultural or structural differences. For example, according to Hofstede's (2001) cultural ratings (see also Hofstede et al., 2010), Canada is a substantially more masculine culture (i.e., emphasis on ambition and accumulation of wealth) than Netherlands (i.e., relative masculinity scores of 52 vs. 14). It is possible that an individual with high levels of skill distortions might be more likely to develop problems with gambling in a culture that places relatively more emphasis on material wealth and winning (i.e., in a more 'masculine' culture).

Limitations

Unexpectedly, only male gamblers were recruited and thus, we are unable to generalize our findings to Dutch female gamblers. While gambling is more common in men than women (Welte et al., 2002), we were neither expecting nor intending to recruit only men into the present study. Previous empirical literature has found numerous differences in gambling practices between males and females. For example, males tend to prefer games requiring skill (e.g., sports betting or cards) while females tend to prefer playing games of luck or chance where no such skill is involved (e.g., slot machines; Toneatto et al., 1997). Indeed, skill-based games were the games predominantly played by participants in our study. Thus, we may have had insufficient variability in Skill/Attitude distortions to see any relation with gambling-related problems. However, this seems unlikely given there was sufficient variability in Skill/Attitude distortions to see relations with gambling behavior. Future research should be sure to recruit an equal distribution of male and female gamblers to allow for between-gender comparisons on different types of gambling-related cognitive distortions.

As alluded to earlier, a possible limitation concerns the relatively small sample size and the consequent impact on power. A *post hoc* power analysis showed that to obtain power of 0.8 for a moderate effect size of $r = 0.30$, 67 participants would have been needed. Thus, with a sample size of 49 participants, the present study was adequately powered to detect large effects but underpowered to detect small effects. Attrition and unmet inclusion criteria further contributed to power issues for detecting statistically significant relations of skill distortions and gambling behaviors at the follow-ups, or for demonstrating significantly stronger correlations of skill distortions with gambling behavior relative to other correlations. Nonetheless, we did detect one significant effect and two marginal trends that are suggestive of the utility of Skill/Attitude distortions in understanding prospective gambling behaviors. Moreover, due to the relatively small sample size in the present study, we were unable to perform Exploratory or Confirmatory Factor Analyses on the GCI and thus unable to fully demonstrate cross-cultural validity of this scale. However, the Cronbach's alphas for the GCI in the present study indicate good internal consistency of the subscales based on the factorial structure of the GCI reported by McInnes et al. (2014). While the two-factor structure of the GCI has been previously established by McInnes et al. (2014), the validity of this distinct two-factor structure in other cultures has yet to be been demonstrated. Thus, a larger study is necessary to confirm the cross-cultural validity of the GCI's factor structure. Further, a larger sample size would permit the use of multiple regression analyses controlling for baseline levels of the outcomes to establish whether GCI cognitive distortions predict changes in gambling outcomes over time. While our study suggests greater baseline cognitive distortions are predictive of greater gambling problems and behaviors over time, it could be that gambling behaviors are predictive of escalations in cognitive distortions over time as opposed to the reverse. However, temporal directionality consistent with cognitive theory (Ladouceur and Walker, 1996) has been previously established in a longitudinal study with a sample of 1,000 Canadian gamblers. Specifically, Yakovenko et al. (2016) found changes in cognitive distortions reliably preceded and predicted increases in gambling behavior, and that this path was stronger than the converse path from gambling behavior to increased cognitive distortions over time. Future longitudinal research should examine such temporality in the Dutch population and with the GCI to determine if Yakovenko et al.'s (2016) directional results are true cross-culturally and for the distortions measured by the GCI.

As the present study was performed online in the comfort of the participants' homes rather than in a controlled, laboratory setting, we are unable to ensure participants completed each component of the study as directed (e.g., alone without distraction). However, the research team did not receive any inquiries for clarification from any of the participants and at least some of the McInnes et al. (2014) results were replicated in the present sample, attesting to their validity.

Lastly, due to the differences between our sample and the one studied in McInnes et al. (2014), the potential cross-cultural differences highlighted in this paper should be interpreted with caution. Future studies directly comparing gambler samples with similar characteristics in Canada, Netherlands, and other countries, will yield results that can be interpreted as cross-cultural differences with higher confidence.

CONCLUSION

Cognitive distortions have been known to play an important role in creating and maintaining disordered gambling (Ladouceur and Walker, 1996). In fact, they are such a fundamental contributor to disordered gambling that they are often targeted in gambling treatment (Ladouceur et al., 1998; Walker et al., 2006; Fortune and Goodie, 2012). Targeting these cognitive distortions in treatment has shown positive results in reducing gambling behaviors and problems (Walker et al., 2006; Fortune and Goodie, 2012). The results of our study suggest there are distinct cognitive correlates that may be associated with certain aspects of disordered gambling, at least in Dutch gamblers. Dutch gamblers who endorse greater Luck/Chance distortions may not gamble more frequently or spend greater amounts of time gambling overall, yet when they do gamble they may engage in more risky gambling as a function of their belief in luck. Dutch gamblers who believe they have greater gambling skill may wager more frequently and spend more time gambling yet this may not necessarily be associated with developing gambling-related problems. Beyond excessive gambling involvement, how and why an individual engages in gambling activities may be an important contributor to developing and/or maintaining excessive or problem gambling (Stewart and Zack, 2008). Moreover, cultural differences may further contribute to disordered gambling by influencing the types of erroneous beliefs gamblers hold. While beliefs in luck and skill both contribute to gambling problems in Canadian gamblers (McInnes et al., 2014), Dutch gamblers do not show the same relation of skill distortions to gambling problems. In Dutch gamblers, beliefs about skill may be more important for contributing to excessive gambling behaviors while beliefs about luck may have a greater influence on developing gambling problems. Importantly, in conceptualizing and understanding cognitive distortions as being composed of two distinct yet overlapping dimensions (i.e., Luck/Chance and Skill/Attitude) each of which have distinct gambling outcome correlates (i.e., gambling problems and behaviors, respectively), we might further our understanding of the cognitive underpinnings of excessive and problem gambling.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Measuring Gambling Reinforcers, Over Consumption and Fallacies: The Psychometric Properties and Predictive Validity of the Jonsson-Abbott Scale

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Traditionally, gambling and problem gambling research relies on cross-sectional and retrospective designs. This has compromised identification of temporal relationships and causal inference. To overcome these problems a new questionnaire, the Jonsson-Abbott Scale (JAS), was developed and used in a large, prospective, general population study, The Swedish Longitudinal Gambling Study (Swelogs). The JAS has 11 items and seeks to identify early indicators, examine relationships between indicators and assess their capacity to predict future problem progression. The aims of the study were to examine psychometric properties of the JAS (internal consistency and dimensionality) and predictive validity with respect to increased gambling risk and problem gambling onset. The results are based on repeated interviews with 3818 participants. The response rate from the initial baseline wave was 74%. The original sample consisted of a random, stratified selection from the Swedish population register aged between 16 and 84. The results indicate an acceptable fit of a three-factor solution in a confirmatory factor analysis with 'Over consumption,' 'Gambling fallacies,' and 'Reinforcers' as factors. Reinforcers, Over consumption and Gambling fallacies were significant predictors of gambling risk potential and Gambling fallacies and Over consumption were significant predictors of problem gambling onset (incident cases) at 12 month follow up. When controlled for risk potential measured at baseline, the predictor Over consumption was not significant for gambling risk potential at follow up. For incident cases, Gambling fallacies and Over consumption remained significant when controlled for risk potential. Implications of the results for the development of problem gambling, early detection, prevention, and future research are discussed.

Keywords: predictive, reinforcers, over consumption, gambling fallacies, CFA, longitudinal, gambling problem

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INTRODUCTION

Gambling availability has increased markedly in recent decades (Arvidsson et al., 2016). This increase has been associated with growth in gambling participation and expenditure. In most jurisdictions where general population surveys have been conducted a majority of adults report taking part in one or more gambling activities on an annual or more frequent basis

(Williams et al., 2012a). In the most recent Swedish national survey 61% of men and 55% of women participated during the past 12 months (Public Health Agency of Sweden, 2016b). Most people who gamble do so infrequently and/or have low levels of expenditure. A minority has higher levels of engagement and is at greater risk of developing gambling-related problems. The prevalence of gambling disorder or serious problem gambling usually ranges from 0.5 to 3%. Substantially, more people experience some loss of control over gambling and subclinical gambling-related harm (Williams et al., 2012a; Abbott et al., 2014). In Sweden, based on the Problem Gambling Severity Index, 0.4% (95% CI 0.28–0.53%) of adults are estimated to be current problem gamblers, 1.3% moderate-risk gamblers and 4.2% low-risk gamblers (Public Health Agency of Sweden, 2016b). This means that approximately one in 10 gambling participants experience at least some form of reduced control over gambling and/or adverse consequences.

There is no unitary theoretical model for the development of gambling disorder or less serious gambling problems. Clinical and epidemiological studies have found strong associations between involvement in some forms of gambling and problem gambling (Stevens and Young, 2010). Cross-sectional studies have identified additional gambling related factors such as gambling fallacies, gambling behavior, commencing gambling at an early age and experiencing a big win that are associated with problem gambling (Rönnberg et al., 1999; Jonsson et al., 2003; Wardle et al., 2011; Williams et al., 2012a). Some sociodemographic groups including males, young adults, low-income people and single status are almost universally found to be at high risk (Abbott et al., 2013). In Sweden, people born outside the country also have elevated risk (Abbott et al., 2014). In addition to some gambling and sociodemographic factors, there are strong associations with personality characteristics including impulsivity, mental health disorders and substance use and misuse (Bruneau et al., 2016).

The emergence of a body of longitudinal research in the gambling field makes it possible to assess whether or not cross-sectional correlates of problem gambling prevalence precede and predict the development and onset (incidence) of gambling problems. During the past decade five large-scale prospective studies have been conducted (Swedish National Institute of Public Health, 2012, 2013; Billi et al., 2014; Romild et al., 2014; Abbott et al., 2015a,b, 2016; el-Guebaly et al., 2015; Williams et al., 2015). The Swedish and New Zealand studies are still in progress.

The foregoing prospective studies have found that gambling-related factors are the strongest predictors of problem gambling development. These factors include experiencing an early big win, commencing gambling at a young age, having family members who gamble regularly and/or are problem gamblers (in the past and currently), frequency of participation, expenditure, number of forms engaged in and gambling as a favored leisure activity. People who experienced past gambling problems were also prone to relapse. Mental health variables including mental health disorders, substance abuse or dependence and behavioral addictions also predicted future problem gambling. In New Zealand, in addition to gambling-related and mental health factors, ethnicity was a strong risk factor. Maori, Pacific Islanders and Asian people were at particularly high risk. High deprivation, experiencing major life events, lower quality of life and psychological stress were further risk factors and high family income and usually gambling with others were protective (Abbott et al., 2015a,b, 2016). Ethnicity was also a risk factor in the Canadian studies, with non-Caucasians being at higher risk.

The prevention of gambling problems and harm has received increased attention in recent years (see Williams et al., 2012b for an overview). Prevention measures include public awareness raising and education, policy initiatives, restrictions on who can gamble and restrictions and alterations to how gambling is provided. The latter category includes 'responsible gambling' measures such as enabling participants to set spending limits and providing feedback on gambling patterns and self-tests for gambling risk or problems.

Early intervention, engaging people before they develop a gambling problem, is an important part of a comprehensive prevention strategy. This calls for the identification of early indicators of problem gambling. As mentioned, heavy gambling engagement is a major risk factor for problem development. To date the role of heavy engagement, consumption and overconsumption in developing problems has not received much attention in its own right (Williams and Volberg, 2014). It has received some consideration as an aspect of loss of control and Currie et al. (2008) have sought to develop low-risk gambling participation limits. The measures include gambling frequency, gambling expenditure and gambling expenditure as a percentage of gross income. While promising, the predictive validity of low-risk limits is yet to be assessed using prospective data.

Gambling-related cognitive distortions and fallacies are relatively commonplace and appear to be risk factors for the development of problem gambling (Leonard and Williams, 2016). Gambling fallacies predicted future problem gambling in the two Canadian prospective studies. Challenging false beliefs about the nature of randomness, over-estimation of skill components in gambling activities and superstitious views about ways to control gambling outcomes through public education campaigns and education programs in schools or at gambling sites may contribute to reducing the incidence of at-risk and problem gambling.

Motives for gambling may also be relevant to problem development and early intervention. As mentioned life events, psychological distress and mental health disorders are risk factors for the development of problem gambling. It is likely that participation in some forms of gambling provide an escape from negative emotions and this could increase gambling exposure and the psychological salience, e.g., negative reinforcement value, of that exposure (Blaszczynski and Nower, 2002). Gambling for escape or distraction was a risk factor for problem development in one of the two Canadian prospective studies. Performance on two Gambling Motives Questionnaire (Stewart and Zack, 2008) subscales, enhancement and emotional coping, have been found to be associated with problem

gambling (MacLaren et al., 2014). In a recent Swedish study, moderate risk gamblers participated for challenge and coping reasons more often than low risk gamblers (Sundqvist et al., 2016).

Existing problem gambling screens have covered aspects of gambling fallacies and the reinforcing aspects of gambling, although not used in longitudinal research. The Victorian Gambling Screen includes three items on the enjoyment of gambling among its twenty items (Tolchard and Battersby, 2010). The full Canadian Problem Gambling Inventory has two items on faulty cognitions and three items on gambling as self-medication (Ferris and Wynne, 2001).

One purpose of the Swedish Longitudinal Gambling Study (Swelogs) is to advance understanding of the early development of problem gambling. The research team sought to identify early indicators, examine relationships between indicators and assess their capacity to predict future problem progression. To this end, two team members developed the Jonsson-Abbott Scale (JAS), including items designed to assess the three domains of gambling reinforcements, gambling over-consumption and gambling fallacies (Romild et al., 2014). The theoretical definition of Reinforcers is that the gambling behavior is psychologically reinforcing in some way. The items were chosen to reflect positive reinforcement as excitement and joy, negative reinforcement as forgetting everything else for a while and a socially rewarding aspect. Over consumption is defined as gambling more than intended and experiencing difficulties in refraining from gambling. The items were chosen to mirror that. Gambling fallacies is defined as the misconception that gambling is a way to make money in the long run and that winnings is related to skill. The rationale for developing a new scale was the lack of an existing short screen covering these three areas. Due to restricted space in the interview/questionnaire, there were three to four items chosen for each domain using a consensus process.

In an 11-year follow-up study of lifetime problem gamblers and matched controls ($n = 423$), the three JAS-domains showed significant Pearson r relationships with SOGS-R: gambling reinforcements 0.48, gambling over-consumption 0.52, and gambling fallacies 0.39. Furthermore, the problem gambling group showed significantly higher scores on all three JAS-domains compared with the controls (Public Health Agency of Sweden, 2015).

The aims of this study are to further examine the psychometric properties of the JAS and assess the predictive validity of this new measure. More specifically, it seeks to assess the capacity of identified JAS dimensions to predict increases in problem gambling risk level and problem gambling over 1 year.

MATERIALS AND METHODS

Data Collection

Data were collected within the Swelogs epidemiological track – a prospective study with four waves of data-collection from Swedish citizens aged 16–84 years at baseline. A stratified random sampling procedure was applied for drawing 15000 individuals from the Swedish register of the total population. Data from the two first waves are used in this study. The baseline wave 1, performed between October 2008 and August 2009, included 8165 participants. In wave 2 6021 participants were reassessed between December 2009 and August 2010. The response rate was 55% (8165/15000) in the first wave and 74% (6021/8165) in the second. Interview and questionnaire data were supplemented by register data. Computer-supported telephone interviews were used as the primary method with postal questionnaires used to follow-up those not reached by telephone. Swelogs design, sampling and methodological details are provided in Romild et al. (2014).

Participants

The 5048 participants (out of 6021) who gambled at least yearly in wave 1 were included in this study. The rationale for this was that only past year gamblers were administered the JAS and PGSI in wave 1. The mean age was 35.2 ($SD = 19.5$) years and 41.7% were women. The sample reduced to 3818 when only participants who reported gambling in both wave 1 and wave 2 were included. The mean age was 36.5 ($SD = 19.5$) years and 40.6% were women.

Measures

Gambling Participation in Wave 1 and Wave 2 – Gambling Risk Potential

Participants were asked about their past 12 months gambling participation in wave 1 and wave 2. Questions covered gambling frequency, time and money spent and modality for nine groups of gambling types. The risk potential for each of the various gambling types was assessed using 7 out of 10 criteria suggested by Meyer et al. (2011). On this basis gambling types were classified as being of low, medium high or high risk (Swedish National Institute of Public Health, 2012). Examples of low risk activities are lotteries (except scratch cards online) and number games at retailers. Medium high risk activities include sports betting (not online), horse betting and online number games. High-risk activities include online bingo, VLTs, casino games and online poker. In the Swelogs study, the medium-high and the high-risk groups both showed distinctly a higher connection with problem gambling than the less than monthly and low-risk-groups that both had very weak connection with gambling problems (Public Health Agency of Sweden, 2016a). Thus, in this study gambling less than monthly was merged with low risk into "Low risk gambling" and medium high and high risk were merged into "High risk gambling." This reclassification also increased statistical power.

All participants were assigned a risk level based on their highest monthly risk gambling participation in wave 1 and wave 2.

Gambling Problem

The Canadian Problem Gambling Severity Index (PGSI) was used in wave 1 and wave 2 to measure gambling problems

TABLE 1 | The Jonsson-Abbott Scale (JAS): items and categories.

Item	Category
(1) I gamble for the excitement	Reinforcer
(2) Gambling is among the most enjoyable things there are	Reinforcer
(3) Gambling can make me forget everything else for a while	Reinforcer
(4) My gambling gives me friends	Reinforcer
(5) I gamble for more money than intended	Over consumption
(6) I gamble a longer time than intended	Over consumption
(7) I gamble when I should have done other things	Over consumption
(8) When gambling, I find it hard to stop	Over consumption
(9) My gambling is a way to make money	Gambling fallacy
(10) When I win, it is due to my skill	Gambling fallacy
(11) If I just gamble enough, my gambling will pay off	Gambling fallacy

(Ferris and Wynne, 2001). It employed the response format Never (0), Seldom (1), Often (2), and Always (3). Participants with an overall PGSI score of 0-2 were classified No problem and those with a score of 3-27 were classified Gambling problem.

Jonsson-Abbott Scale

The 11 JAS-items were asked in wave 1 only. The directions for objective scale development outlined by Clark and Watson (1995) served as a guide when developing the scale. The items are Likert type with a seven-step response scale ranging from "Do not agree at all" to "Agree completely." The items (see **Table 1**), are categorized into Reinforcers, Over consumption and Gambling fallacies.

Analysis

We investigated if the scales represented three different constructs by subjecting the items to a confirmatory factor analysis (CFA; Bollen, 1989). The postulated three-factor representation of the 11-item gambling scale was empirically tested using the CFA procedures with maximum likelihood estimation in Lavaan (Rosseel, 2012). To evaluate model fit the likelihood-ratio χ^2 test, the Root-Mean-Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Normed Fit Index (NFI) and the Tucker-Lewis Index (TLI), were used. Browne and Cudeck (1993) suggested that RMSEA values of 0.08 or less indicate reasonable error of approximation in relation to the degrees of freedom, while values of 0.05 or less indicate close fit. We relied on MacCallum et al. (1996) suggestion to use 0.01, 0.05, and 0.08 to indicate excellent, good, and mediocre fit, respectively. The recommended cut-off values of TLI, CFI, and NFI are 0.95 or higher (Hu and Bentler, 1999).

To address the question concerning predictive power of JAS we used logistic regression analyses (Menard, 2002) with gambling risk potential and incident cases as dependent variables and the three factors (i.e., Reinforcer, Over consumption, Gambling Fallacy) as predictor variables. The likelihood ratio test was used to test our models. It is a test of the significance of the difference between the likelihood ratio (−2 log likelihood) for our model with predictors (called model chi square) minus the likelihood ratio for baseline model with only a constant in the model. Significance at the 0.05 level or lower means that the model with the predictors is significantly different from the one with the constant only (all 'b' coefficients being zero). It measures the improvement in fit that the explanatory variables make compared to the null model. Chi square is used to assess significance of this ratio. Akaike's Information Criterion (AIC) and the Bayesian Information Criterion (BIC) were also used to evaluate the models. Both are based on *−2 Log Likelihood*. The value of AIC and BIC can be used to compare various models for the same data set to determine the best-fitting model. The model having the smallest value is usually preferred (Akaike, 1974; Kass and Wasserman, 1995). Both unstandardized (B) and standardized coefficients (β) are reported in the logistic regression analyses (Menard, 2011).

Ethics Statement

The original Swelogs study plan was approved by the Regional Ethical Review Board in Umeå in 2008 (Dnr 08-78). Additional ethical applications have been submitted in subsequent years due to changes in questionnaires for consecutive data collections. For this study an ethical application for secondary analysis was submitted (Dnr 2016/410-32). All submitted applications have been approved.

RESULTS

In **Table 2** the CFA results (i.e., standardized factor loadings) for the proposed three factor model are presented. The results of the CFA analysis indicate a mediocre fit between the three-factor model and the data ($\chi^2[41] = 1077.742$; $p < 0.001$; RMSEA = 0.071; $p < 0.05$; 90% CI [0.067, 0.075]; CFI = 0.939; TLI = 0.918; NFI = 0.94). Closer examination of the modification indices of the CFA showed that item 10 "When I win, it is due to my skill" loaded on two latent factors. When that path was freed, the modified model indicated a significantly better fit ($\chi^2[40] = 665.356$; $p < 0.001$; χ^2 diff[1] = 412.390; $p < 0.001$; RMSEA = 0.056; $p < 0.05$; 90% CI [0.052, 0.060]; CFI = 0.963; TLI = 0.949; NFI = 0.936). The results suggest that this item should be included in both factors, removed from the scales, or reformulated. Overall, the results confirm that these three constructs are empirically separated because of the specific variance of each factor, in other words, the corrected for attenuation correlations are far from 1.00. We also contrasted our two proposed three factor models with a one factor solution ($\chi^2[44] = 1077.742$; $p < 0.001$; RMSEA = 0.105; $p < 0.05$; 90% CI [0.101, 0.108]; CFI = 0.857; TLI = 0.821; NFI = 0.854) which showed a worse fit when both our original model was compared (χ^2 diff[3] = 1393.671; $p < 0.001$) and when our modified model was compared (χ^2 diff[4] = 1816.052; $p < 0.001$).

The internal consistency reliability (Chronbachs's alpha) of the three scales Reinforcers, Over consumption and Gambling fallacies are 0.67, 0.82, and 0.58, respectively.

TABLE 2 | Standardized factor loadings based on confirmatory factor analysis.

	F1	F2	F3
(2) Gambling is among the most enjoyable things there are	0.71		
(3) Gambling can make me forget everything else for a while	0.70		
(1) I gamble for the excitement	0.54		
(4) My gambling gives me friends	0.42		
(6) I gamble a longer time than intended		0.82	
(5) I gamble for more money than intended		0.74	
(8) When gambling, I find it hard to stop		0.68	
(7) I gamble when I should have done other things		0.66	
(10) When I win, it is due to my skill			0.52
(9) My gambling is a way to make money			0.63
(11) If I just gamble enough, my gambling will pay off			0.70

F1 = Reinforcer; F2 = Overconsumptions; F3 = Gambling Fallacy. The latent factor correlation between F1 and F2 was 0.73, between F1 and F3 0.69, and between F2 and F3 0.69.

TABLE 3 | Logistic regression analyses ($n = 3818$).

	Risk potential time 2		Incident cases time 2	
	Step 1	Step 2	Step 1	Step 2
Predictors		B (β)		
Gambling fallacy	0.26*** (0.06)	0.16*** (0.07)	0.25** (0.12)	0.22* (0.04)
Reinforcer	0.37*** (0.09)	0.19*** (0.08)	0.20 (0.14)	0.15 (0.03)
Over consumption	0.15** (0.03)	0.05 (0.02)	0.26* (0.08)	0.25* (0.04)
Risk potential time 1	–	2.327*** (0.35)	–	0.61** (0.04)
−2 Log likelihood	3913.318	3220.950	920.197	912.962
AIC	3921.318	3230.950	928.197	922.962
BIC	3946.304	3262.184	954.052	922.962
Nagelkerke	0.12***	0.35***	0.05***	0.06***

**p < 0.05, **p < 0.01, ***p < 0.001. Standardized coefficients (beta weights) within parentheses were computed with formula 5 reported in Menard (2004). AIC, Akaike information criterion; BIC, Bayesian information criterion.*

The overall internal consistency of the JAS scale is 0.83. The correlation between JAS (all items) and PGSI is $r = 0.49$ and the correlations between subscales and PGSI are Reinforcers 0.34, Over consumption 0.59, and Gambling fallacies 0.36.

To investigate the predictive validity of the JAS scale two logistic regression analyses were conducted. The statistical significance of individual regression coefficients (i.e., βs) was tested using the Wald chi-square statistic. From **Table 3** it is evident that in step 1 Gambling fallacies, Reinforcers and Over consumption were significant predictors of risk potential ($p < 0.05$). Gambling Fallacies and Over consumption were also significant predictors of incident cases ($p < 0.05$) and Reinforcers showed a tendency of significance ($p = 0.053$). In the second step, risk potential measured at time 1 was added to the equation. In this second step, the predictor Over consumption was not significant with respect to risk potential. Further, Reinforcers was not a significant predictor of incident cases at time 2. The results suggest that the model with three predictors should be applied to the data ($p < 0.05$). Both AIC and BIC showed better values for the proposed model with the three predictors than for the models using only the constants as predictors.

DISCUSSION

The current study examined the dimensionality and predictive validity of JAS. A three-factor model was confirmed by CFA and the subscales of JAS were found to have moderate to high internal consistency. Reinforcers, Over consumption and Gambling fallacies were significant predictors of gambling risk potential and Gambling fallacies and Over consumption were significant predictors of problem gambling onset (incident cases) at follow-up. When controlling for gambling risk potential at baseline, the dimension Overconsumption was no longer significant in predicting risk potential. This is not unexpected given that high gambling risk potential at baseline is a strong predictor of a high gambling risk potential at follow-up, and regular participation in high risk gambling activities has a connection with overconsumption as an early sign of problem gambling. For incident cases, Gambling fallacies and Over consumption were still significant when controlling for risk potential. This is consistent with findings from recent longitudinal gambling research. While various aspects of gambling behavior are strong predictors of problem gambling development, other factors including gambling fallacies, psychological distress and disorders, addictions, personality attributes and sociodemographic factors

also have an influence (Swedish National Institute of Public Health, 2012, 2013; Billi et al., 2014; Williams et al., 2015; Abbott et al., 2016).

In this study, high-risk gambling potential level and problem gambling are partly explained by different variables. These results appear to fit well with the etiological model suggested by Williams et al. (2015). They also highlight the role of reinforcements in starting to gamble at a higher risk-level – something not covered in the etiological model. This matter requires further investigation.

Given that the three JAS subscales and regular participation in high risk gambling activities predicted the onset of future moderate risk and problem gambling, these measures are likely to be important in the detection of early problem gambling development. They reflect behaviors and beliefs that could provide a focus for problem gambling prevention programs. Programs could include education to counter gambling fallacies and a variety of policy, regulatory and other measures to prevent and reduce overconsumption.

There is a lack of brief multidimensional screens covering factors relevant to the development of gambling problems. JAS contributes to extant research in the field by providing, in a relatively brief format, a measure with three dimensions that are theoretical and empirical risk-factors for and early signs of problem gambling. This makes JAS suitable for use in longitudinal research. It may also inspire the development of new scales that assess these dimensions more fully.

Strengths

One strength of this study is that it draws on data from on a large, random general population sample that is nationally representative. Additionally, it is prospective, had relatively low attrition and involved repeated assessment of the same participants 12 months apart. This is a prerequisite for assessing a scale's predictive validity. The response format used in JAS gave the possibility to respond to the statements in a more nuanced way. This is an asset for the CFA in that it increases response variation.

Limitations

The study has a number of limitations related to the design and choices made due to limited statistical power. One is the use of PGSI $\geq$ 3 as an indicator of problematic gambling. The conventional cut score for problem gambling is $\geq$ 8, although Williams and Volberg (2014) have made a strong case for using $\geq$ 5 instead. Collapsing gambling participation risk categories is another weakness. Measurement invariance between subgroups in age and gender was not controlled for and attenuation, due to relatively low reliability in two of the JAS dimensions, will have underestimated their predictive capacity. Additionally, the JAS was administered at baseline only. Consequently, it was not possible to look at the dimensions' stability and how they varied along with change in gambling behavior. Another limitation is that the reliability of JAS is not yet fully explored (e.g., test–retest).

The correlations between two JAS subscales and PGSI were moderately low. However, the PGSI is a unidimensional measure (Miller et al., 2013) whereas the JAS was designed to assess three distinct factors considered likely to be involved in the early development of problem gambling. The JAS, in contrast to the PGSI, was not intended to measure problem gambling *per se*. While overlap between JAS and PGSI performance, administered at the same time, was anticipated, it was expected to be low to moderate.

Future Research

Problem gambling prevention requires more research, perhaps especially with regard to early interventions. Based on the study findings further investigation is called for on the role of Over consumption, Reinforcers and Gambling fallacies in progression to higher risk gambling levels and the development of gambling problems. This could include examining relationships between these and other relevant constructs and how these relationships change over time with at-risk and problem gambling. Ideally such studies would extend well beyond 12 months.

The JAS could be enhanced by the addition of supplementary items and assessing its psychometric properties in a variety of settings. The reliability of JAS also needs to be further examined. Offering the JAS or similar instruments at gambling sites combined with interventions such as feedback on consumption and/or the facility to pre-commit to gambling expenditure limits warrant investigation.

AVAILABILITY

The JAS is freely available for use in research and clinical practice. At time of writing, the instrument has been translated by professional translators into English and is also available in Swedish. Current versions are available at http://spelforskning.se/jas.

AUTHOR CONTRIBUTIONS

JJ and MA participated in data collection. JJ and AS did the data analysis. JJ, MA, and AS drafted the manuscript. All authors have read and suggested improvements in several iterations of the manuscript preparation.

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Conflict of Interest Statement: JJ and MA are members of the Swelogs advisory board. JJ is an employee at Sustainable Interaction, a private company working with responsible gambling consultancy and online training with the gambling industry. JJ is involved in ongoing research at the Norwegian gambling operator Norsk Tipping. PC has been the primary investigator of two larger treatment studies on pathological gambling funded by the Public Health Agency of Sweden. He has also received 3-year funding from FORTE, a government agency under the Swedish Ministry of Health and Social Affairs, for an Internet-delivered treatment for concerned significant others of people with problem gambling. In addition, he has received two research grants (Svenska spel and PAF) specifically devoted to only cover the university costs of employing two Ph.D.-students. Both Ph.D.-positions were publically announced and applicants were independently assessed by three reviewers. Finally, PC and JJ has served as an unpaid gambling expert for the National Board of Health and Welfare (Socialstyrelsen) which is a government agency in Sweden under the Ministry of Health and Social Affairs.

The other author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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SYSTEMATIC REVIEW
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Cognitive Remediation Interventions for Gambling Disorder: A Systematic Review

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Various therapeutic approaches are available for the treatment of gambling disorder (GD), especially cognitive behavioral therapy (CBT; the most widely used treatment). However, CBT has high dropout and relapse rates as well as non-compliance issues, which may be partly due to resistance to changing core characteristics, such as executive functioning, attention, and emotional regulation abnormalities. Finding new therapeutic approaches to treat GD is thus a key challenge. Cognitive remediation (CR) interventions represent a promising approach to GD management, which has recently been demonstrated to have efficacy for treating other addictive disorders. The objective of this review is to describe the possible benefits of CR interventions for GD management. Two systematic searches in MEDLINE and ScienceDirect databases were conducted up until January 2017. Potential neurocognitive targets of CR interventions for GD were reviewed, as is the use and efficacy of such interventions for GD. While there is evidence of several neurocognitive deficits in individuals with GD in terms of impulsive, reflective, and interoceptive processes, the literature on CR interventions is virtually absent. No clinical studies were found in the literature, apart from a trial of a very specific program using Playmancer, a serious videogame, which was tested in cases of bulimia nervosa and GD. However, neurocognitive impairments in individuals with addictive disorders are highly significant, not only affecting quality of life, but also making abstinence and recovery more difficult. Given that CR interventions represent a relatively novel therapeutic approach to addiction and that there is currently a scarcity of studies on clinical populations suffering from GD, further research is needed to examine the potential targets of such interventions and the effectiveness of different training approaches. So far, no consensus has been reached on the optimal parameters of CR interventions (duration, intensity, frequency, group vs. individual, pencil-and-paper vs. computerized delivery, etc.). Although no firm conclusions can be drawn, CR interventions represent a promising adjunct treatment for GD. Such a novel therapy could be associated with common interventions, such as CBT and educational and motivational interventions, in order to make therapies more effective and longer-lasting and to decrease the risk of relapse.

Keywords: gambling, cognitive remediation, cognitive dysfunction, cognitive bias modification, therapy

INTRODUCTION

Gambling Disorder (GD) is defined as a "persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress" (American Psychiatric Association, 2013). Included in the spectrum of addictive disorders in the 5th version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), GD shares many similarities with substance use disorders (SUD), at the behavioral, psychological, and neurobiological level (Reilly and Smith, 2013). The prevalence of lifetime GD has been estimated at around 0.4–1.0% (American Psychiatric Association, 2013).

Various therapeutic approaches are available for the treatment of GD, which include psychological interventions (cognitive behavioral therapy, motivational interviewing; Merkouris et al., 2016), mindfulness (de Lisle et al., 2012), pharmacological medications (opioid antagonists (Victorri-Vigneau et al., 2017), glutamate agonists, antidepressant drugs, mood stabilizers; Grant et al., 2014), self-help and peer-support (Merkouris et al., 2016). Recently, novel and promising treatment options have also been explored, such as Virtual Reality (Giroux et al., 2013) and neuromodulation (repeated Transcranial Magnetic Stimulation; Grall-Bronnec and Sauvaget, 2014 or Transcranial Direct Current Stimulation; Sauvaget et al., 2015). Psychological interventions, especially cognitive behavioral therapy (CBT), appear to be the most widely used treatment for the management of GD with demonstrated efficacy (Korn and Shaffer, 2004; Gooding and Tarrier, 2009; Stea and Hodgins, 2011). However, the extent and durability of effectiveness remains unclear (Cowlishaw et al., 2012) and CBT are associated with high dropout rates, relapses, and non-compliance issues (Jimenez-Murcia et al., 2012; Goudriaan et al., 2014; Tarrega et al., 2015; Merkouris et al., 2016). This might be partly due to resistance to change of several core characteristics in GD, such as executive functioning, attention, and emotional regulation (self-control strategies, tolerance to frustration, and impulsivity traits) (Merkouris et al., 2016). Finding novel therapeutic approaches for the treatment of GD is a key challenge, especially those that can target patients with more severe symptoms, high levels of impulsivity and impaired emotional regulation.

Cognitive remediation (CR) interventions represent a specific neuropsychological treatment aimed at improving cognitive functioning, in order to reduce the impact of a disease in a patient's life. They have been defined as "*a behavioral training based intervention that aims to improve cognitive processes (attention, memory, executive function, social cognition, or metacognition) with the goal of durability and generalization*" (Barlati et al., 2013; Medalia and Bowie, 2016). Therefore, in contrast to CBT, the primary goal of CR interventions is to improve the thinking process rather than the content of thoughts. CR interventions are based on the neuroplasticity hypothesis, which states that the brain has an inherent capacity to change and reorganize dependent on our experiences throughout life. CR interventions are expected to induce neuroplastic changes through the use of targeted cognitive exercises and training, either using "paper and pencil" or computerized exercises, leading to concomitant cognitive/behavioral changes that could be transferred into clinically relevant benefits for the patients (in terms of disease symptoms, autonomy, or social interactions) (Mishra and Gazzaley, 2014).

CR interventions consist of various techniques and methods, with the common aim of restoring neurocognitive abilities and/or compensating for impairments in them. To date, most clinical experiences and research findings have focused on schizophrenia and, overall, three major types of CR interventions have emerged over the past 20 years (that are not mutually exclusive) (Medalia and Bowie, 2016):

(1) The compensatory/strategy-based approach, which focuses on counteracting cognitive difficulties by acquiring new and efficient skills to transfer to the real world, and modifying the local environment to foster the successful completion of activities in everyday life. Using cognitive exercises, programs may target different skills, such as cognitive flexibility, memory, and planning. This approach attempts to recruit intact cognitive processes in order to bypass cognitive deficits and improve targeted behaviors and functional outcomes.
(2) The restorative approach has an underlying assumption that improvements in cognition are mediated by neuroplasticity. This approach targets cognitive impairments directly through repeated task practice, careful titration of task difficulty, and maintenance of high levels of accurate performance. It is usually computer assisted.
(3) The social cognitive approach, which focuses on ameliorating deficits in taking others' perspectives (theory of mind) into consideration, improving alterations in recognizing expressed affect, and retraining information processing biases. These programs are specifically designed for patients with schizophrenia who present with multiple impairments in social cognition.

CR interventions have been applied to many neurocognitive disorders, including Alzheimer's disease (Bahar-Fuchs et al., 2013), schizophrenia (Paquin et al., 2014), multiple sclerosis (O'Brien et al., 2008), Parkinson disease (Nombela et al., 2011), and depression (Calkins et al., 2015). There is strong evidence to support their efficacy (Rezapour et al., 2016). The interest in using such interventions in the treatment of addiction has recently emerged, due to their expected therapeutic effects and potential to regain control over addictive behavior, especially by enhancing inhibitory control (Sofuoglu et al., 2013). CR interventions represent a promising option for the care of addicts, and have already demonstrated efficacy in the treatment of alcohol dependence (Rupp et al., 2012) and drug addictions (Sofuoglu et al., 2013). They could be integrated with other addiction treatments using a holistic and patient-centered approach (Rezapour et al., 2016), and must be adapted by targeting either only one or multiple cognitive functions (Rezapour et al., 2015) to correspond with the specific neurocognitive needs of individual patients (Bayley et al., 2014).

The cognitive alterations of individuals with GD have been the subject of multiple studies and reviews (Goudriaan

et al., 2004; Brevers and Noël, 2013; Hønsi et al., 2013). In particular, these studies have been conducted from 2000 to the present, supporting the grouping of GD within the framework of addictive disorders, as they were previously restricted to SUD before the publication of the DSM-5 (American Psychiatric Association, 2013). They identified several common neuropsychological deficits between those with GD and SUD, especially for executive functioning and attentional biases [comparison with cocaine-dependent individuals (Albein-Urios et al., 2012); comparison with alcohol-dependent individuals (Goudriaan et al., 2006a), comparison with methamphetamine-dependent individuals (Kalechstein et al., 2007)].

The objective of this review is to describe the potential benefits of CR interventions for the management of GD. It includes an updated review of cognitive alterations as potential neurocognitive targets in CR interventions for GD, and a review of the use and efficacy of such interventions for the treatment of individuals with GD.

METHODS

Two systematic reviews of the literature were conducted to identify all the relevant publications concerning:

(1) Potential neurocognitive targets of CR interventions for GD management. The aim was to identify the major neurocognitive processes altered in individuals with GD that could be targeted by CR interventions. We should emphasize that this first review was made to provide support for the use of CR interventions in GD management, and was not aimed at identifying the neurocognitive mechanisms underlying the development or maintenance of GD.
(2) The use and efficacy of CR interventions for the treatment of GD. The aim was to explore whether literature exists on the use and efficacy of such interventions for individuals with GD.

For both of these reviews, we complied with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) (Moher et al., 2009).

Search Strategy

The searches were performed in MEDLINE and ScienceDirect databases up until January 17th 2017 and were limited to articles published in English. For the first review on potential targets for CR interventions in GD, the search terms were a combination of medical subject headings (MeSH) terms and keywords including: "pathological gambling," "problem gambling," "gambling disorder," "gambling addiction" AND "cognitive functions," "cognitive dysfunction," "executive function," "memory disorders," "neurocognitive disorders," "attention," "cognitive impairment."

For the second review on the use and efficiency of CR interventions in GD, the search terms were also a combination of MeSH terms and keywords including: "gambling," "pathological gambling," "problem gambling," "gambling disorder," "gambling addiction" AND "cognitive remediation therapy," "cognitive training," "cognitive rehabilitation therapy," "cognitive retraining," "cognitive bias modification," "executive training," "cognitive remediation," "cognitive reappraisal."

A manual search and screening of the bibliographic references of the studies included were performed in addition to the database search.

Flow diagrams of the two systematic review processes are presented in **Figures 1**, **2**.

Eligibility Criteria

For the first review on potential targets for CR interventions in GD, studies had to fulfill the following criteria to be included:

(1) The study focused on gambling.
(2) The sample was composed of individuals with GD. As the definition of pathological gambling has largely evolved during recent years, we included studies on both problem/excessive gambling [as defined by a score of 5 or more at the South Oaks Gambling Screen (SOGS) (Lesieur and Blume, 1987) or a score of 8 or more at the Problem Gambling Severity Index (PGSI) (Ferris and Wynne, 2008)] and diagnosed GD (according to the DSM or the International Classification of Diseases [ICD] diagnostic criteria).We thus excluded studies conducted on subthreshold forms of problem gambling (especially studies using a threshold of under 5 on the SOGS or under 8 on the PGSI, or with less than the required number of DSM diagnostic criteria) and studies conducted on self-identified problem gamblers. We made this choice because CR interventions are directed toward patients with a confirmed GD or problem/excessive gambling practice.
(3) The aim of the study was to identify the neurocognitive impairments related to GD (for example, attention deficits, altered executive functioning, or memory disorders), which are part of the endophenotype and may be the target of specific CR interventions. As a consequence, only studies that have at least one neurocognitive measure as an outcome were included. We excluded from this review the clinical expression of certain cognitive dimensions often measured with questionnaires, which are part of the exophenotype and the targets of CBT, such as gambling-related cognitive distortions and impulsivity (understood as a personality trait).
(4) The study was a clinical study (e.g., any research study involving human volunteers intended to add to medical knowledge, including pilot studies, observational studies, and randomized clinical trials) (U.S. and National Institutes of Health, 2017).
(5) The study was original research (not a case report, editorial article, or a review).

For the second review on the use and efficiency of CR interventions in GD, studies had to fulfill the following criteria to be included:

(1) The target problem was a GD.
(2) The sample was composed of individuals with GD.
(3) The study had a therapeutic aim (for example, efficiency or effects of the CR interventions on individuals with GD).

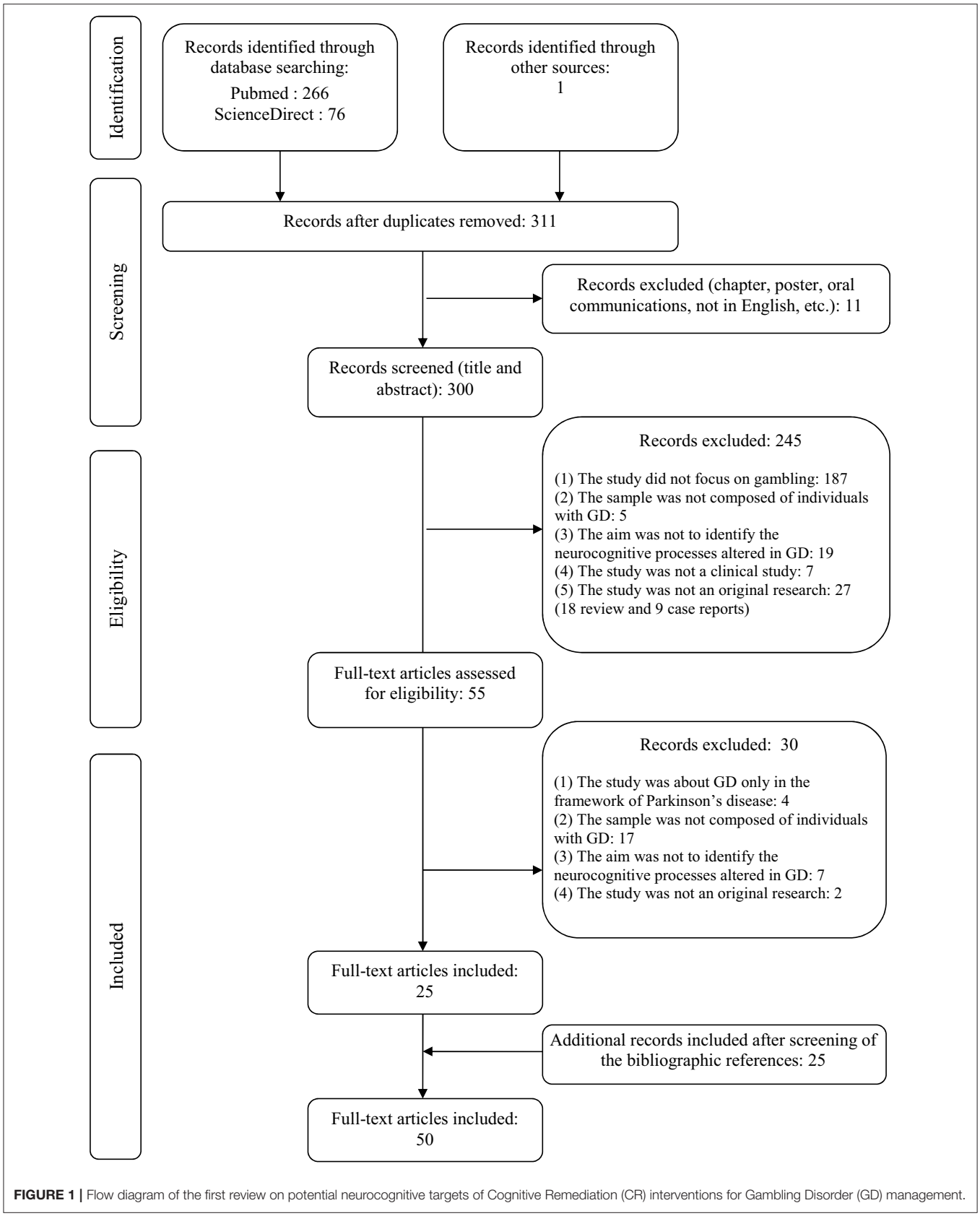

FIGURE 1 | Flow diagram of the first review on potential neurocognitive targets of Cognitive Remediation (CR) interventions for Gambling Disorder (GD) management.

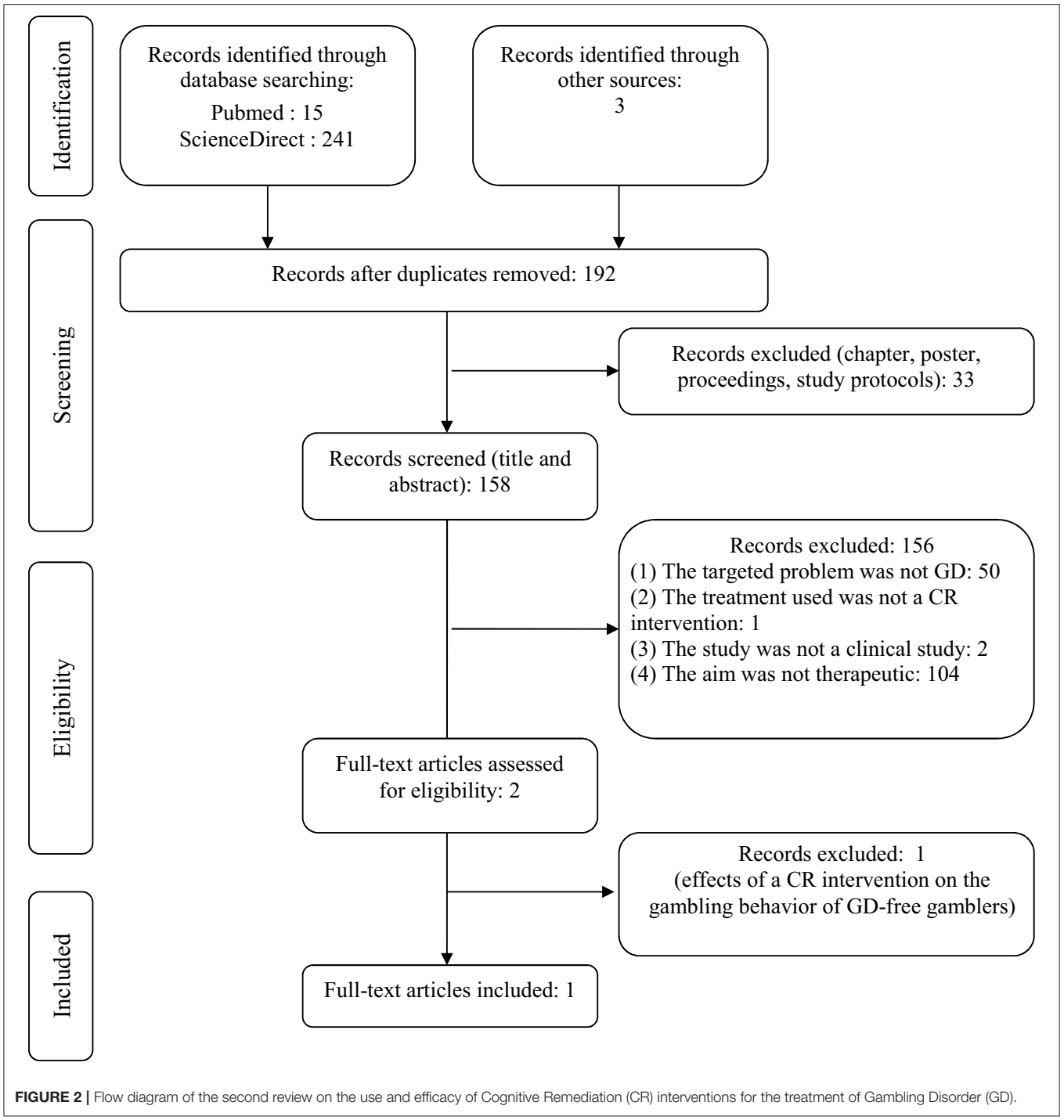

FIGURE 2 | Flow diagram of the second review on the use and efficacy of Cognitive Remediation (CR) interventions for the treatment of Gambling Disorder (GD).

(4) The study investigated an intervention that can be classified as a CR intervention. This comprises any type of compensatory, restorative, or social-cognitive approaches.
(5) The study was a clinical study (U.S. and National Institutes of Health, 2017).

Study Selection and Data Extraction

All studies were screened for eligibility based on their titles and abstracts by the first and last authors (GCB and MGB) for the first review and by the first two authors (GCB and MB) for the second review. Reasons of exclusion are reported in the flow diagrams (**Figures 1**, **2**). Then, the full texts of all eligible studies identified in the search processes were read and several pieces of information were extracted: sample size and participants, mean age of participants, main exclusion criteria, objectives, design, tasks, or questionnaires used to measure neurocognitive functions, main results, and limitations.

RESULTS

First Review on Potential Targets for CR Interventions in GD

As depicted in **Figure 1**, 50 studies fulfilled all the criteria to be included in the review. Studies are reported in chronological order, in order to highlight changes in the methods used or results obtained over time.

We observed that the high number of studies wrongly identified by the database search was due to the huge use of the Iowa Gambling Task (IGT) in the scientific literature to assess decision-making related processes in a large number of pathologies. As the IGT includes the word "Gambling" in its name, the database search initially led to an overinclusion of studies.

The methods of all studies included are presented in Supplementary Table 1. The oldest study was conducted in 1995, but the large majority of the studies were conducted between 2000 and the present. This exploration of neurocognitive deficits in individuals with GD is quite recent, and was especially accentuated with the preparation of the DSM-5. Of the 50 studies included, only one had a longitudinal design (Goudriaan et al., 2008), with the aim of finding neurocognitive predictors of relapse. The absence of other longitudinal studies raises the question of the maintenance of neurocognitive alterations in individuals with GD over time, and of their effects on treatment outcomes and relapses. The studies included were predominantly conducted on males and used low sample sizes, with nearly half of them (45%) being conducted on less than 30 individuals with GD. This could be due to the difficulty of conducting in-depth neurocognitive assessments on a large sample. However, as neurocognitive studies often include a large number of dependent variables, a low sample size may result in biased conclusions. Also, inclusion criteria varied a lot and specifically, assessment tools and thresholds used to include individuals with GD varied highly, from a SOGS score over or equal to 5 to a real clinical diagnosis of GD. Studies were conducted on a large range of GD severity, and mixed problem gamblers (PrG) and pathological gamblers (PG) (for details see Supplementary Table 1). This may have led to results being biased and/or limited. Another factor bringing possible bias to the results is the fact that most of the studies compared PG or PrG to non-gambler controls (see Supplementary Table 1 for more details). In this condition, it is hard to identify whether the alterations identified are related to gambling itself or to GD-related psychopathology.

The main results of this review are synthetized in Supplementary Table 2. We have only presented studies that compared PrG or PG, to healthy controls or non-problem gamblers, in order to identify only those neurocognitive alterations that are due to specific gambling psychopathology (forty-four studies of the fifty initially included). To facilitate understanding, the various cognitive functions assessed in the studies included were grouped within eight categories: (1) general cognitive functioning; (2) memory and working memory; (3) attention; (4) cue-reactivity for gambling cues; (5) metacognition; (6) executive functioning with six sub-categories (response inhibition, concept generation and abstraction, planning, time estimation, flexibility, and decision-making); (7) social cognition; and (8) visuo-spatial and visuo-constructive abilities. This presentation is obviously simplistic and the grouping of cognitive functions is debatable, as one function cannot be assessed purely by one cognitive task and because certain high-level functions require the involvement of others. It has only one objective—to be clearer.

General cognitive functioning appeared to be preserved in most cases, as was the capacity for memory. Visuo-spatial and visuo-constructive abilities appeared alerted compared to controls, although these alterations were assessed in only two studies (Forbush et al., 2008; Hur et al., 2012).

Specific assessment of attention capacities is relatively rare in the literature and only two studies where this was addressed were identified in the present review (Vizcaino et al., 2013; Lorains et al., 2014b). This is considerably less than in the review that focused on attentional biases in problem gambling conducted in 2013 by Hønsi et al. (2013), who identified 11 studies, but with no restriction on the threshold to identify problem or pathological gamblers. In the two studies selected for the present review, results are divergent. While Lorains et al. (2014b) found no differences between individuals with GD and controls, the introduction of gambling-related cues as stimuli for assessing the maintenance of attention-induced attentional bias, showed no correlation between PG severity and degree of attentional bias (Vizcaino et al., 2013). In the framework of the present review, only one study by Sharpe et al. involved examining cue-reactivity for gambling cues in individuals with GD (Sharpe et al., 1995). Other studies on cue reactivity in GD were performed with the aim of identifying brain regions involved in craving (Limbrick-Oldfield et al., 2017), which was considered outside the scope of the present review. In their study, Sharpe et al. concluded there is a higher influence of gambling-related cues on physiological arousal (measured by skin conductance levels, frontalis electromyography, and electrocardiography) in individuals with GD compared to non-problem gamblers, even high-frequency non-problem gamblers, although it was conducted on a small sample size. These effects were limited when a cognitive distraction task was added, especially for individuals with GD, suggesting that competing thoughts are useful when confronted with gambling stimuli.

Metacognitive judgement was examined in only two studies, and this was mainly by assessment of the level of confidence in various risky choices, both in (Brevers et al., 2013) and out (Goodie, 2005) of a gambling context. Outside of a gambling context, individuals with GD displayed greater overall overconfidence and bet acceptance (Goodie, 2005). In an experimental gambling situation (the IGT), individuals with GD were more confident than controls for disadvantageous decisions, but not for advantageous ones (Brevers et al., 2013), leading to a recurrent higher tendency to make disadvantageous choices and, consecutively, to lower performances in this task (Cavedini et al., 2002; Goudriaan et al., 2005, 2006b; Lakey et al., 2007; Forbush et al., 2008; Roca et al., 2008; Kertzman et al., 2011; Ledgerwood et al., 2012; Brevers et al., 2014; Lorains et al., 2014a).

What can clearly be concluded from Supplementary Table 2 is that the majority of the research to date has been focused on

executive functioning (93% of the 44 distinct studies presented in Supplementary Table 2), especially on decision-making (57%), and to a lesser extent on response inhibition (50%). Response inhibition has been assessed within two modalities: cognitive inhibition (interference control) and motor inhibition (inhibition of a prepotent response). Cognitive inhibition has been assessed classically with the Stroop test, and predominantly with the classical word and color Stroop test (11 studies out of 12). Only one study used an addiction version of the Stroop test, which has the same principles as the classical Stroop, but with addiction-related stimuli. Results were divergent. Of the 12 studies identified, only seven identified alterations in cognitive inhibition based on the Stroop task, but three of the five studies that did not pick up any difference involved very small sample sizes, or aimed to compare GD to other pathologies [one study was of a comparison with bulimia nervosa and included 15 PG (only females) (Alvarez-Moya et al., 2009); one study was of a comparison with obsessive compulsive disorder and included 16 PG (Hur et al., 2012); one study included 13 PG (only males) (Potenza et al., 2003)]. More specifically and unexpectedly, the only study that used an addiction version of the Stroop test (Lorains et al., 2014b) did not find any differences between inhibition performance in PrG and controls. However, the task was programmed in such a way that the cognitive response was recorded through a motor response rather than a vocal response, which may have induced bias. Motor inhibition was assessed with both Go/No Go or related paradigms (GNG paradigms—six studies identified) and Stop Signal Task or related paradigms (SS paradigms—eight studies identified). These tasks measure different components of motor inhibition: the GNG paradigms assess inhibition of the initiation of a motor response with automatic inhibition likely to occur, whereas the SS paradigms assess the interruption of an on-going motor response with automatic inhibition unlikely to occur (Verbruggen and Logan, 2008; Billieux et al., 2014). Out of the six studies conducted with GNG paradigms, five reported alterations in motor inhibition (Goudriaan et al., 2005; Fuentes et al., 2006; Kertzman et al., 2008, 2011; Roca et al., 2008). The only study that did not identify any difference between individuals with GD and controls was performed using a reward-punishment version of the GNG paradigm, with incentives for learning given for every correct response, and on a small sample size (Leiserson and Pihl, 2007). The alterations identified mainly concerned the number of errors (both omission and commission errors) and response times to Go trials, with both faster (Goudriaan et al., 2005; Roca et al., 2008) or longer (Kertzman et al., 2008, 2011) reaction times recorded. This varying effect on reaction times may be explained by the higher variability in reaction times in individuals with GD than in controls (Kertzman et al., 2008). Only half of the eight studies based on SS paradigms identified an alteration in motor inhibition, although the four studies with negative results (Ledgerwood et al., 2009, 2012; de Ruiter et al., 2012; Lorains et al., 2014b) were conducted on PG rather than PrG, possibly indicating a GD of higher severity. Indeed, Odlaug et al. demonstrated that performance at the SST was poorer for PG than for at-risk gamblers or non-problem gamblers, whereas at-risk gamblers displayed the same level of performance as non-problem gamblers (Odlaug et al., 2011). When an effect was observed, lower motor inhibition was associated with longer Stop Signal Reaction Time (SSRT) (Goudriaan et al., 2006a; Odlaug et al., 2011; Billieux et al., 2012; Grant et al., 2012b) and, to a lesser extent, longer Go reaction times (Odlaug et al., 2011). Importantly, in the one longitudinal study, the lowering of SSRT, which is indicative of a poor capacity for motor inhibition, was associated with a higher likelihood of relapse 1 year after treatment (Goudriaan et al., 2008). It seems that alterations in motor inhibition are related more to the difficulty in inhibiting initiation of an action, rather than to the difficulty of stopping an action once initiated. Making a parallel with gambling behavior, it is presumably harder for gamblers to avoid engaging in a gambling action than to interrupt it once initiated.

The large part of the neuropsychological studies on GD has been concerned with decision-making abilities. As illustrated in Supplementary Table 2, there is no doubt a decision-making deficit exists in individuals with GD. This deficit can take the form of: (1) delay discounting difficulties with a lower ability to delay rewards; (2) lower impact of negative feedback on future decisions; (3) sensitivity to monetary reward and punishment with higher cognitive and physiological sensitivities to gains and, to a lesser extent, lower cognitive, and physiological sensitivities to losses; (4) impaired risk assessment with altered anticipatory physiological reactions to risky decision-making, and (5) a general trend toward making disadvantageous risky and/or ambiguous choices, even when no monetary rewards are involved (Linnet et al., 2006). From Supplementary Table 2 it can be seen that the task predominantly used to assess decision-making capacities was IGT (44% of the 25 distinct studies on decision-making, compared to 4–12% for the other tasks), which assesses both decision-making under ambiguity (throughout the beginning of the task, the patient does not have conscious knowledge of which are the good decks, and makes choices under uncertainty) and risk (after several trials, the patient gradually acquires conscious knowledge of which are the good decks and thus can consciously make risky choices). Individuals with GD display lower global performance, and no shift toward advantageous card selection during the task compared to controls. It appears that alterations in decision-making abilities are only present in a gambling context (typically, the IGT) or, at least, when monetary rewards are involved (Billieux et al., 2012), but not outside of these contexts (Ledgerwood et al., 2009; Fauth-Bühler et al., 2014). Motivational aspects (especially of a monetary kind) of decision-making are thus of crucial importance, and may be more automatized and difficult to control in individuals with GD than "cold" reflective ones, which appear to be preserved. These decision-making deficits are all the more important in that they are predictors of the probability of relapse 1 year after treatment (Goudriaan et al., 2008).

Concept generation and abstraction has been largely assessed in GD (16% of the 44 distinct studies presented in Supplementary Table 2), especially using the Wisconsin Card Sorting Test (WCST) (86% of the studies exploring concept generation and abstraction). This test, which can serve as a measure of general executive functioning and of reactive flexibility, can also constitute an index of concept generation and abstract reasoning

by mainly utilizing the number of categories completed, number of non-perseverative errors, learning-to-learn score and percentage of conceptual responses. In most cases, individuals with GD display a similar number of completed categories as controls, but altered learning-to-learn scores and percentages of conceptual response scores. This might indicate a preserved global performance, but difficulty with concept generation. Results on non-perseverative errors are more mitigated.

Flexibility can be assessed in two ways: reactive flexibility (the ability to adapt strategies dependent on feedback from the environment) and spontaneous flexibility (the ability to spontaneously produce a flow of ideas, with no feedback from the environment). In the selected studies ($n = 10$), reactive flexibility was assessed mainly both with the WCST (a higher number of perseverative errors indicating a poorer flexibility) (60%) and the Trail Making Test (TMT) (30%). In both tests divergent results were obtained, with half of the studies producing negative results in the WCST and two out of three studies doing so in the TMT. Spontaneous flexibility was mainly assessed with fluency tests [the Controlled Oral Word Association Test being the most used (67%)]. As for reactive flexibility, results were divergent, with half of the studies producing negative results. As can be seen in Supplementary Table 2, the results about flexibility is quite unstable over time, as more recent studies did not find deficits in both reactive and spontaneous flexibility.

Finally, other functions were assessed, but in a smaller number of studies, making it difficult to derive conclusions. Planning had been assessed in two studies, both using the Tower of London test (Goudriaan et al., 2006a; Ledgerwood et al., 2012) and concluding that there were altered planning abilities in individuals with PG. Estimation of time was also assessed, but in only one study (Goudriaan et al., 2006a), in which lower performance in individuals with PG than controls was demonstrated.

Only one study explored social cognition in GD (Kornreich et al., 2016). Using three emotion recognition tasks (musical, vocal, and facial), Kornreich et al. demonstrated that individuals with GD presented non-verbal perception deficits, in the same way as alcohol-dependent patients do. This represents the first study that explored social cognition deficits in GD. Unfortunately, the study had several limitations and requires repetition.

Finally, two studies explored visuo-spatial and visuo-constructive abilities, and both came to the conclusion that impairments were present (Forbush et al., 2008; Hur et al., 2012).

Second Review of the Use and Efficiency of CR Interventions in GD

As depicted in **Figure 2**, despite the fact that the initial database search resulted in 192 records, only one study fulfilled all the criteria for inclusion in the review. The main reasons for exclusion were that the targeted problem was not GD (the fifty studies excluded were mainly about schizophrenia, neurodevelopmental disorders, neurodegenerative disorders, or attention deficit hyperactivity disorder) or that the aim was not therapeutic (the one-hundred and four studies excluded were mainly on the benefits of videogames for cognitive functioning, cognitive enhancement in healthy subjects, aging well, pedagogy, or productivity management, or were theoretical papers for modeling cognitive or neurobiological functioning in gambling or other domains).

We suppose that there are two reasons for the huge number of studies incorrectly identified by the database search. Firstly, CR interventions are often game-like exercises so that the use of the word "gambling" (often linked to the word "gaming") within the search strategy could have led to an over-identification of studies not related to GD. Secondly, the majority of the studies excluded were about CR interventions on healthy subjects (to improve or take advantages of cognitive training-like exercises in everyday life), but our focus was on studies into the use of CR interventions as a therapeutic approach for patients with GD.

Due to studies on the use of CR interventions for addictions being quite recent in the literature, and because the use of such interventions is less obvious for GD than for substance-related addictions due to the absence of the neurotoxic effects of a psychoactive substance, there is a scarcity of studies on the use CR interventions in GD in the literature. Our review was, hence, inconclusive, and we failed to find any program or even any exercises where CR interventions had been applied to individuals with GD, apart from one study of a serious videogame (Playmancer) used in GD, in addition to CBT (Tarrega et al., 2015).

Serious videogames are not strictly part of CR interventions, but they are close in some ways. Playmancer is a serious video-game with biofeedback, designed to treat impulse control disorders (Jimenez-Murcia et al., 2009; Fernandez-Aranda et al., 2012; Tarrega et al., 2015). It has already been used in patients suffering from bulimia nervosa (Fagundo et al., 2013; Giner-Bartolome et al., 2015). This application may be referred to as a CR intervention, as the purpose of this technique was to improve emotional regulation and self-control, reducing arousal, and enhancing decision-making, and planning (Tarrega et al., 2015). CR interventions are mostly provided through computer-assisted technologies, and serious videogames have become an interesting way forwards for cognitive training being also innovative tools that are highly motivating for the majority of users. Preliminary results were interesting with a positive effect on impulsivity, expressions of anger and other psychopathological symptoms, but no evidence of any benefits in terms of dropout rates and relapses was observed (Tarrega et al., 2015). However, this technique is still novel and very few studies have been reported on its relevance to, and efficacy in treating, addictive behavior. The two studies (the one on bulimia nervosa and the one on GD) were uncontrolled and used small unrepresentative samples.

Another attempt to set up a CR program for gambling was proposed by Stevens et al. but this time in a sample of healthy volunteers (Stevens et al., 2015). As a consequence, this study was not included in the present review, but it should still be mentioned here. Stevens et al. stated that the training of motor inhibition, especially by including stop signals in a gambling task, influences gambling by reducing approach behavior and altering the motivational value of gambling outcomes (Stevens et al., 2015). Further research is needed to generalize these results

to individuals with GD, but the results support the potential of CR interventions in managing GD.

DISCUSSION

The two reviews reported here have identified a paradox. While there is evidence of several neurocognitive deficits in individuals with GD, any literature on CR interventions is almost absent. Research into CR interventions on GD is just beginning and we expect there to be many more studies in future. There were no clinical trials found in the literature, apart from a report of the use of a very specific program using Playmancer, a serious videogame, tested in bulimia nervosa and GD (Fagundo et al., 2013; Tarrega et al., 2015). Yet, neurocognitive impairments in addicted patients are of great significance, not only affecting quality of life, but also making abstinence and recovery more difficult. In GD, these neurocognitive impairments lead to an increased risk of becoming, or remaining, addicted to gambling, but are also strong predictors of gambling relapse (Goudriaan et al., 2008). Therefore, it is very important to act on these impairments within the framework of care.

What Are the Potential Targets for CR Interventions?

Since the early 2000s, the dual-process model of addiction has been the one largely developed (Strack and Deutsch, 2004; Evans and Coventry, 2005). Strack and Deutsch identified two systems determining social behavior: a reflective system that generates behavioral decisions based on knowledge about facts and values, and an impulsive system eliciting behavior through associative links and motivational orientations (Strack and Deutsch, 2004). The dual-process model of addiction postulates that there is an imbalance between a strong activation of the impulsive system and a relatively weak activation of the reflective processes, which leads to the development and the persistence of addictive behaviors (Boendermaker et al., 2015). This model was applied to behavioral addictions, and especially to gambling, where its relevance has been demonstrated to the understanding of both general gambling behavior and GD (Evans and Coventry, 2005). Interestingly, Brevers and colleagues suggested a development of this model with a combination of three key neural systems leading to engaging in and maintaining gambling: (i) a hyperactive "impulsive" system (fast and automatic, motivation-driven and with no deliberate cognitive control); (ii) a hypoactive "reflective" system (slow and deliberate, providing top-down supervision of behavior, and thoughts); (iii) an interoceptive system (bottom-up translation of somatic signals, at the junction between impulsive and reflective systems) (Brevers and Noël, 2013). The results of the first review indicate that the three systems are largely altered in individuals with GD, despite a lack of alterations in general functioning.

Alterations of the Impulsive System

Alterations of the impulsive system may lead to learned associations through classical conditioning (Brevers and Noël, 2013), development of cognitive biases on the betting outcomes (Evans and Coventry, 2005) and hypersensitization toward gambling-related cues (Brevers and Noël, 2013). Associative representations may then develop between gambling and positive affects, which may induce orientation (engagement) and maintenance of attention toward gambling-related cues and reactivation of gambling-related schemes of action by gambling-related cues, making it difficult for the gambler to control gambling urges. This area of research has to be developed, as the scarcity of studies on the attentional biases and implicit associations, especially in individuals with GD, does not allow the driving of any formal conclusions (only two studies on attentional biases and none on implicit associations between gambling-related cues and representations in memory). In their review on attentional biases, Molde et al. suggested that findings with respect to GD are generally in accord with those concerning substance users and abusers (Molde et al., 2010). Working on attentional biases and implicit associations may reduce the activation of the impulsive system to the benefit of the reflective system, giving the addicted gambler the best chance of controlling his behavior.

Alterations of the Reflective System

Alterations of the reflective system, and especially executive functioning, have been studied more. A large part of the research on reflective processes has focused on response-inhibition and decision-making capacities.

Alterations in response inhibition

Cognitive and motor inhibition (both of the engagement in an action and suppression of an already-engaged action) have been demonstrated to be altered, but the literature is divergent in some aspects. Indeed, nearly one third of the studies identified, which assessed response inhibition in GD, concluded with negative results (no alterations in individuals with GD). This may have been due to the heterogeneity of the tasks used to assess response inhibition, even if there is a sort of a consensus toward three tasks: a Stroop test for cognitive inhibition, with both the classical task or the addiction variant; GNG paradigms (inhibition of engagement in a motor action), and SS paradigms (suppression of an already-engaged motor action) for motor inhibition. However, there exist many variants of each task, making it difficult to produce homogeneous results. Alterations in response inhibition in individuals with GD are supposed to decrease the higher-order control in the impulsive system, so reinforcing impulses to engage in, or maintain, gambling activity (Brevers and Noël, 2013). Enhancing response inhibition, especially in association with gambling-related cues, should be viewed as an equally relevant goal of gambling treatment as work on attention and implicit association, making it possible to restore the balance between impulsive and reflective systems and so to enhance efficient control over gambling behavior.

Alterations of decision-making processes

Studies on decision-making deficits have focused on several processes: delay discounting; use of feedback for future decisions; sensitivity to monetary rewards and punishments; anticipatory markers of risk assessment (which are part of the interoceptive system), and general decision-making capacities in risky and/or

ambiguous situations. Whatever the process explored, the literature is relatively unanimous and stable in concluding that impairment is present. Delay discounting impairment is characterized by a lesser ability to defer a reward, especially when the reward is high (Petry, 2001; Dixon et al., 2003; Ledgerwood et al., 2009; Billieux et al., 2012; Kraplin et al., 2014). Individuals with GD have been shown to display altered sensitivities to both rewards and punishments, with an increased sensitivity to rewards (Hewig et al., 2010; Brevers et al., 2014; Lorains et al., 2014a) and a decreased sensitivity to punishments (Sharpe, 2004; Lorains et al., 2014a). Insensitivity to losses have sometimes been found to be less pronounced than hypersensitivity to wins (Hewig et al., 2010), especially insensitivity to near losses (Kreussel et al., 2013). This imbalance between sensitivity to wins and losses could result in difficulty emotionally differentiating (subjective excitement) between wins and losses, especially when based on physiological arousal, and so to take feedback into account for making future decisions (Sharpe, 2004). More specifically, individuals with GD seem to attribute less weight to negative feedback for future decisions (Brand et al., 2005; Goudriaan et al., 2005; Hewig et al., 2010). All of these alterations lead to lower decision-making performances in gambling-like situations, but the performance is preserved in other contexts (Ledgerwood et al., 2009; Fauth-Bühler et al., 2014). Decision-making difficulties can lead both to increased losses and the continuation of gambling activity despite losing.

Alterations of other executive functions

Other alterations in executive functioning identified in this review are concept generation and flexibility, albeit with results differing between studies. Impairments in concept generation and/or flexibility may lead to difficulties in associating the outcomes of choices and corresponding feedback. While an individual with no alteration will soon realize the random character of gambling outcomes, an impaired individual may consider that gambling outcomes are not the results of random contingencies and may rather try to explain contingencies with non-valid justifications such as acting in a certain way, wearing certain trousers, throwing the dices more or less strongly, etc. This may induce and exacerbate erroneous thoughts about gambling outcomes and contribute to the maintenance of gambling behavior. Given the link between flexibility, concept generation and inhibition (for example, switching from one set to another in flexibility tasks depends on the inhibition of the previous pertinent set), it is likely that it is ultimately impairments in inhibition that indirectly influence performances on flexibility and/or concept generation tasks, which may explain the variation in the results in the literature. Future studies should, therefore, focus on the identification of such individual associations, and their relationship with performance.

Alterations of metacognition

Another part of the reflective system is concerned with the metacognitive judgment of decisions. While performing poorly on decision-making tasks, individuals with GD constantly showed higher overconfidence on (wrong) choices (Goodie, 2005; Brevers et al., 2013). As argued by Brevers and Noël (2013), poor decision-making capacities can be driven by poor metacognition. Altered sensitivities to both rewards and losses (Sharpe, 2004; Goudriaan et al., 2006b; Hewig et al., 2010; Brevers et al., 2014; Lorains et al., 2014a) may represent poor monitoring abilities. This may induce a reduction of the flow of information toward the metacognitive library of strategies (Nelson and Narens, 1990), leading in turn to poor adjustment of the cognitive processes involved in the action (attention mobilization, switching of strategies, inhibition of the action, etc.). The lowered ability to take feedback into account, especially negative feedback (loss), for future decisions (Brand et al., 2005; Goudriaan et al., 2005; Hewig et al., 2010) may provide a good illustration of this impaired metacognition. This part of the research on GD is very poor, as there have only been two studies, one conducted in 2005 (Goodie, 2005) and one in 2013 (Brevers et al., 2013). However, it could be of interest to explore the metacognitive capacities in individuals with GD, as this may show up the self-perception of the inability to control behavior and so a lack of motivation to stop it. Therapeutic work on metacognitive capacities could thus be based on overconfidence in terms of making bad choices and the perceived inability to stop gambling.

Alterations of the Interoceptive System

At the frontier between the impulsive and reflective systems, the interoceptive system can both exacerbate the activation of the impulsive system and undermine the control of the reflective system (Brevers and Noël, 2013). Except studies conducted to identify the brain regions (mainly the insula) activated in cue reactivity (Limbrick-Oldfield et al., 2017), research in this area is very poorly represented. However, physiological arousal in response to gambling may be experienced subjectively as urges (Brevers and Noël, 2013) and these induce implicit associations between certain physiological reactions to gambling-related cues and cravings. For example, Goudriaan et al. found that individuals with GD had decreased heart rates after both wins and losses, while healthy controls had an increase after wins and a decrease after losses (Goudriaan et al., 2006b). This may reinforce the difficulties in monitoring gambling contingencies and thus to adjust behavior accordingly. Sharpe et al. also concluded that there was higher cue reactivity in individuals with GD, which could be limited by using competing thoughts (Sharpe et al., 1995). The interoceptive system may also be involved in anticipatory somatic markers of risk assessment. Indeed, somatic reactions have been observed at an early stage of risky decision-making, i.e., during the few seconds before making a risky choice. These reactions have been found to be altered in individuals with GD, who showed lower anticipatory skin conductance levels and heart rate decreases for disadvantageous choices compared to healthy controls (Goudriaan et al., 2006b). Also, alpha-amylase levels decreased with disadvantageous choices for individuals with GD, but not for controls. Restoring the balance of the interoceptive system in therapy can be beneficial for both reducing its influence on the impulsive and reflective systems, and for diminishing urges for gambling and cravings, which are thought to represent important factors in persistence and relapse (Cornil and Billieux, 2014).

Synthesis and Therapeutic Propositions

Taken together, findings suggest that individuals with GD present with several neurocognitive disruptions in all three of the systems involved in addition (impulsive, reflective, and interoceptive). These could represent one of the mechanisms underlying the development and persistence of GD (Romanczuk-Seiferth et al., 2014) and of treatment failures (Alvarez-Moya et al., 2011). The reference treatment for the management of GD for several decades now has been CBT (Korn and Shaffer, 2004; Gooding and Tarrier, 2009; Stea and Hodgins, 2011). Although efficient, at least in the short term, this kind of therapy has several limitations: (i) it does not directly target the endophenotypic neurocognitive processes underlying the addictive vulnerability of the patient, which have been demonstrated to predict relapse in the long term (Goudriaan et al., 2008); (ii) it does not allow work on "hot" emotional states, especially those driven by somatic arousal, which could largely impact on decision-making (Brevers and Noël, 2013); (iii) it is insufficient for a non-negligible proportion of patients in terms of reducing high levels of impulsivity, whereas it is an important target for the prognosis of treatment outcomes in addictive disorders (Boog et al., 2014; Stevens et al., 2014). As a consequence, CR interventions represent a novel and promising approach to gambling addiction care.

According to the dual process model of addiction (Evans and Coventry, 2005; Vandermeeren and Hebbrecht, 2012), gambling addiction is the result of a disturbed balance between impulsive and reflective processes, with strong automatic processes producing continuous impulses to gamble ("bottom up" processes) and low executive control being less effective in regulating them ("top down" processes). CR interventions should be focused on both impulsive (attentional biases and implicit associations) and reflective (executive functioning, especially response inhibition, flexibility and decision-making, and metacognitive judgement) neurocognitive alterations. By working on both impulsive and reflective processes, CR interventions may restore the balance between automatic and controlling levels, allowing the patient to regain control over behavior. Moreover, it is assumed that CR interventions do not only impact this balance, but also allow for an improvement in cognitive restructuring by mobilizing the necessary cognitive resources, and can generalize to non-cognitive aspects. For example, in a study on alcohol-dependent patients, it was found that CR interventions were effective in improving cognitive impairments, and also that the benefits generalized to non-cognitive outcomes such as psychological well-being or cravings (Rupp et al., 2012). Further, interventions aimed at improving patients' cognitive functioning could increase the efficiency of well-established CBT, thus helping to prevent relapses (Pedrero-Perez et al., 2011). CR interventions should be carried out with CBT to improve efficacy. Indeed, using a combination of therapeutic methods adapted to a patient's specific clinical and cognitive needs, especially when CBT is insufficient, will allow practitioners to act on overall functioning, and so to improve the chances of reducing the symptoms of gambling. Biofeedback to complement CR interventions by acting on the interoceptive system should be considered a particularly relevant therapeutic add-on to both CBT and CR interventions.

To date, such validated CR programs do not exist in the field of GD and so have not been tested. We reporting on several CR techniques that may be useful for the treatment of GD, especially with respect to cognitive alterations identified in the first literature review, and to draw a parallel with an addictive disorder for which CR interventions have been studied to a greater extent: alcohol-use disorder.

What Can be Learnt from Studies Focusing on CR Interventions in Patients Suffering from Alcohol Use Disorder?

Analyzing studies on use of CR interventions in disorders sharing common symptoms (particularly impulsivity and attentional deficit) with GD, such as alcohol-use disorder, is an important approach to establishing research into CR interventions in GD. Indeed, several CR interventions have produced evidence for its efficacy for SUDs [NEuro COgnitive REhabilitation for Disease of Addiction (NECOREDA) program for drug addictions (Rezapour et al., 2015); Cognitive Bias Modification for SUDs (Boendermaker et al., 2015)] or other addictive-like disorders (Cognitive Bias Modification for excessive multiplayer online gamers; Rabinovitz and Nagar, 2015), which suggest a utility of such interventions for all addictive disorders. Note that the comparison with alcohol-dependence is relevant, but, unlike an addiction without substance, some portions of the deficits are associated with chronic, heavy alcohol use, which may arise from the neurotoxic effects of alcohol itself. Restoration of lost cognitive abilities using practice or functional recovery, which exploits undamaged abilities and environmental aids, are the two approaches used in alcohol dependence (Bates et al., 2002).

There is extensive evidence in the literature for cognitive deficits associated with drug use and the efficacy of CR interventions. A recent review by Rezapour et al. reported on 13 clinical trials conducted between 1994 and 2012 (seven on alcohol dependence, five on polysubstances and one on stimulants) and 9 registered clinical trials, which were ongoing, on neurocognitive rehabilitation (three on cocaine, one on heroin, two on alcohol, one on nicotine, one on polysubstances, one unreported) (Rezapour et al., 2016). It was concluded that the use of CR interventions for addictive disorders was promising both in terms of cognitive functions (particularly attention and memory) and outcomes of addiction treatment, with respect to adherence and retention. However, broad variation in the parameters of studies was noted, such as the study's time period, CR tools and methods used (restorative methods vs. strategy/compensatory-based approaches), durations and settings for treatments (inpatient vs. outpatient, individual vs. group session). Such heterogeneity reflects a lack of appropriate and standard protocols and guidelines for CR interventions for addictive disorders. Hence, there are many challenges before CR interventions can be implemented in the treatment of addictions.

Most of the CR interventions in patients suffering from alcohol-use disorder have consisted of attention bias modification (Molde et al., 2010) and approach bias retraining. Supplementary Table 3 summarizes the main CR programs used in alcohol-use disorder, including a comparison with the only program found for GD (Playmancer). Most of the programs used

were computerized. However, most of the studies suffer from using small samples, the lack of long-term measures and the lack of an appropriate control group, which limits us to drawing only very general conclusions. Moreover, the targeted populations were highly heterogeneous, from inpatient to outpatient, and alcohol-dependent patients to abstinent alcoholics. Furthermore, the number, duration and frequency of sessions were also greatly heterogeneous, and follow-up assessments were not systematic and short when they were carried out (1–12 months). To the best of our knowledge, there have been no group session programs, only individual ones. Most of the programs were associated with another current treatment, usually CBT, but there was no consensus with respect to when CR intervention occurred (before or during CBT, for example). The goal of each intervention was consistent between programs: retraining single or multiple functions in order to improve outcomes of the treatment of alcohol dependence in terms of recovering and relapse.

Application to GD: Training the Impulsive System

A specific form of CR intervention named cognitive bias modification (CBM) specifically targets automatic processes and has produced promising results in the treatment of addiction (Sofuoglu et al., 2013). CBM has been defined as the "direct manipulation of a target cognitive bias, by extended exposure to task contingencies that favor predetermined patterns of processing selectivity" (Cristea et al., 2015). In a recent meta-analysis, it was remarked that there had been an "exponential growth in the research employing these CBM procedures," especially in recent years (Cristea et al., 2015).

According to Schoenmakers et al. selective attention training via ecologically validated stimuli may lead to reduced attentional bias toward drug-related cues in the real environment, which may be translated into significant effects in treatment outcomes (real-life applications) (Schoenmakers et al., 2010). These authors identified three factors that appear to increase effectiveness of CBM interventions, based on the literature: (i) motivating the participants; (ii) the presentation of a large number of different stimuli in training; (iii) the performance of multiple training sessions.

Research on CBM has focused mainly on two types of interventions: attention bias modification (ABM) and interpretative cognitive bias modification (CBM-I) (Macleod, 2012; Cristea et al., 2015).

The principle of ABM involves teaching participants to avoid the addiction-related stimuli (usually pictures or words) by directing their attention, without their knowledge, to neutral or other relevant stimuli (Cristea et al., 2015). According to Posner's work on attention, it can be decomposed in several stages: the orientation of attention toward a relevant stimulus, and the disengagement of attention from non-relevant stimuli before the re-orientation of attention toward a relevant stimulus (Douilliez and Philippot, 2008). In a subthreshold sample of problem gamblers (scoring $\geq$ 3 at the SOGS), Brevers et al. found an effect of gambling-related stimuli on both the orientation (faster detection of gambling-related stimuli) and the disengagement (slower shifting of attention from gambling-related stimuli) of attention (Brevers et al., 2011). Such training programs are usually performed based on the Visual Probe Task, and have demonstrated efficiency (Lopes et al., 2015).

The principle of CBM-I is similar, but focuses on training participants to consistently interpret complex information, such as ambiguous sentences, in a particular direction, either positively or negatively, and more rarely neutrally (Cristea et al., 2015). CBM-I is frequently used in anxiety and depression but has not yet been applied to addiction (Wiers et al., 2013).

CBM also included other interventions, such as concreteness training or approach and avoidance training (Cristea et al., 2015). In the latter, participants are instructed to respond with an approach movement (for example, pulling a joystick that increases the size of a picture) to certain stimuli and respond with an avoidance movement (for example, pushing a joystick that decreases the size of a picture) to others (Wiers et al., 2011). This zooming effect generates a feeling of approach or avoidance toward the associated stimulus, respectively (Wiers et al., 2011).

Application to GD: Training the Reflective System

Controlling processes are usually trained by using either cognitive tasks used for the assessment of the related cognitive function (such as Go No Go, Stop Signal Task, Tower of London, etc.) or exercises that put the patient in a supposed ecological situation.

The large part of addictive-related inhibition training is based on motor inhibition training. Training programs are mainly based on GNG or SS paradigms, the purpose of such training being to increase self-control toward addiction-related items (Turton et al., 2016). The principle of motor inhibition training is to enhance the inhibition of addiction-related cues embedded in those paradigms (Benikos et al., 2013), by associating no-go or the stop signal with addiction-related cues. In studies on motor inhibition training it has been reported that there are both direct effects on inhibitory performance and indirect effects on alcohol or food consumption (Benikos et al., 2013). However, training programs must take into account several parameters, such as the difficulty of a task, which can be manipulated by reaction time deadlines (Benikos et al., 2013), number of sessions or the cues to be used.

Training inhibition can indirectly influence other reflective processes, such as flexibility or decision-making. Interestingly, in a recent study on a gambling sample without GD (Stevens et al., 2015) it was highlighted that the presence of stop signals in gambling decision-making tasks influences gambling by reducing approach behavior and altering the motivational value of the gambling outcome. This is one of the arguments for the transferability of inhibition training to gambling situations, which could have an influence on overall gambling behavior in real-life. As such, training the reflective system should focus on training of the inhibition of gambling-related cues.

Application to GD: Training the Interoceptive System

Physiological arousal in response to gambling-related cues has been proposed to be experienced subjectively as feelings of urges (Brevers and Noël, 2013) and so to have the ability to induce cravings. This phenomenon could be reeducated

using biofeedback intervention, which consists of getting the patient to visualize his physiological response to certain stimuli, in order to help him to develop voluntary control over his body, especially in situations that pose the risk of excessive gambling. This could improve control over urges for gambling. Biofeedback interventions offer a promising therapeutic route in psychiatric/psychological care (Canadian Agency for Drugs and Technologies in Health, 2014), and could potentially be successfully applied to gambling addiction treatments. A complementary approach would be to combine CBT and biofeedback, especially in order to associate distractive or competing thoughts and biofeedback. Indeed, the work of Sharpe had demonstrated that the increased physiological arousal in response to gambling-related cues was limited when a cognitive distraction task was added, especially for individuals with GD (Sharpe et al., 1995). As a consequence, training a gambler to exercise voluntary control over his physiological reactions in gambling situations by combining visualization of his reactions with relaxation exercises or mindfulness, and the use of distractive thoughts, could reduce cravings and lead to reduction or arresting of gambling behavior.

Several studies in the literature have focused on mindfulness training in gambling (de Lisle et al., 2012; Shonin et al., 2013; Garland et al., 2014). Garland et al. suggested that mindfulness training can modify neuroplasticity and so target the risk chain of addiction at the attention-appraisal-emotion interface (Garland et al., 2014). de Lisle et al. in their review, proposed a model of relationships between mindfulness, mechanisms of action, and problematic gambling behavior (de Lisle et al., 2012). However, the paucity of research prevents any demonstration of the clear efficacy of mindfulness-based interventions for GD. However, mindfulness training could be relevant if incorporated into GD treatments such as CBT or biofeedback.

Recommendations for Future Clinical Studies on the Use of CR Interventions for GD Management

Initially, research on certain potential targets for CR interventions in GD should be developed, and especially on clinical samples. Studies need to focus on attentional biases and implicit associations, cue reactivity, and metacognition. Some specific issues, such as a possible association between craving and attentional bias in GD, have been identified and should be investigated in greater depth (Hønsi et al., 2013). Research on social cognition, with only one exploratory study extracted from the present review (Kornreich et al., 2016), must also be developed. Indeed, impaired social cognition can induce difficulties in terms of interacting with others, indirectly inducing or reinforcing social isolation, which is a factor in the initiation and maintenance of gambling behavior.

Secondly, as the assessment tools used have been found to be heterogeneous, the development of a standardized assessment battery for GD is required. This could serve both to provide more relevant results from neurocognitive studies (with several samples assessed using the same battery), to assess the specific cognitive impairments of each patient in order to adapt the CR intervention accordingly (personalized medicine) and to confirm the benefits for the patient on the trained capacities throughout the intervention (patient-centered approach). This could also provide support for the development of a specific training program. Future research must, therefore, focus on determining which tools are best for measuring neurocognitive impairments in relation to GD, which are those that are optimal for re-training them, and how to adapt both the assessment and training tools to each individual (with personalized cues for example).

Research on CR interventions for GD management is desirable, according to previous research on substance-related addictive disorders. For example, the extensive review on the efficacy of CR interventions for substance-related addictive disorders (Rezapour et al., 2016) highlighted that: (i) only a few studies included follow-up assessments and so controlled studies using long-term follow-up should be done in order to explore longer-term outcomes; (ii) earlier studies reported using "paper-and-pencil" for cognitive training, while more recent studies have mainly used computers to deliver intervention; (iii) most studies have applied programs that include a range of cognitive domains; (iv) the exact cut-off point of cognitive performance still potentially benefit from CR interventions remains unknown (some studies were conducted with "cognitively-impaired" patients, whereas some of them took into account patients without notable cognitive impairments and also found a positive effect of CR interventions); (v) some parameters of CR interventions are still unknown such as duration, intensity, frequency of treatment, preferred setting, individual vs. group; (vi) the efficacy of computer-based vs. "paper and pencil" training approaches has not been directly compared in the context of addiction treatment; (vii) further research is needed regarding single vs. multiple targets. These recommendations could be equally applied to future studies on CR interventions for GD management, which have to include follow-up assessments, to use appropriate control groups, to investigate the optimum mode for delivering interventions (paper-and-pencil or computer-assisted), to explore whether programs should focus on single vs. multiple cognitive domains and to determine the breaking point below which a CR intervention will not be beneficial for the patient. Optimal parameters for CR interventions to reach higher efficacies should also be defined: duration (number of sessions, duration of a single session), intensity (increased difficulty of tasks, frequency of sessions), and modality (individual vs. group, home exercises).

Furthermore, CR interventions must be implemented in combination with usual treatment, i.e., CBT. They can also be combined with other approaches such as biofeedback, to improve the global efficacy of treatment using synergistic actions (holistic approach). Virtual reality, for which there is demonstrated evidence of efficacy for the management of GD (Giroux et al., 2013), may provide another route for the improvement of such interventions. Rezapour et al. suggest using a short contract, which include the patient's own goals, for facilitating behavioral changes and also to provide reinforcement for positive behaviors (Rezapour et al., 2016).

CR interventions should also be tailored to individual needs in order to gain more potent effects. Personalized cues should be used as often as possible, specific modules of training should be selected according to the specific impairments of the patient and level of difficulty of baseline exercises, with gradually increases in the level of difficulty adjusted to the patient's level so as to achieve optimal patient performance over CR sessions (Eack, 2012).

Finally, working on treatment adherence is crucially important when dealing with patients suffering from addictive disorders, who usually show low adherence and high drop-out rates (Rezapour et al., 2016). As CR interventions usually require repetitive training and include home exercises, they could be perceived as really boring and restrictive for patients. Serious video-games, such as Playmancer (Tarrega et al., 2015), represent an innovative and promising way forward in providing CR interventions. They allow the motivation and encouragement of patients within a ludic training framework, and the combination of virtual reality, biofeedback, CR interventions and CBT within the same tool.

CONCLUSION

GD is a significant public health issue (The Lancet, 2017). Due to the long-term failure of interventions for GD, there is a need to develop novel and innovative approaches that enhance current treatments (Raman et al., 2014). Thanks to recent research in neurocognitive functioning in GD, neurocognitive impairments have been highlighted in motivational (impulsive), controlled (reflective), and physiological (interoceptive) processes, which provide possible targets for novel CR interventions, such as retraining programs. Such novel therapies may be associated with commonly used interventions (such as CBT, educational and motivational interventions) in order to make therapeutic interventions more effective, longer-lasting, and decreasing the risk of relapse.

Given that CR interventions are a relatively novel therapeutic approach to addictions and that there is currently a scarcity of studies, in the literature, on clinical populations suffering from GD, further research is needed to examine the potential targets of such interventions and the effectiveness of different training approaches. The characteristics of a patient who could benefit from CR interventions are still unknown, particularly concerning neurocognitive deficits (which cut-off point?). So far, no consensus has been reached on the optimal parameters for CR interventions: duration, intensity, frequency of treatment, group vs. individual, single vs. multiple cognitive targets, pencil-and-paper vs. computerized delivery, optimal monitoring sessions, feedback type, measuring outcomes, etc. Even though no firm conclusions can be drawn, CR interventions represent a promising adjunct treatment for GD treatment. Rigorously designed studies with appropriate control groups and longer term follow-ups need to be implemented in future studies. This may lead to the development of interventions that could be of value to individuals with GD.

AUTHOR CONTRIBUTIONS

GC-B and MG-B are the heads of the IGNACE group and obtained the MRSEI grant from the ANR. GC-B and MB conducted the literature research. GC-B and MG-B screened all the studies for eligibility in the first review and GC-B and MB for the second review. GC-B read and reported data from all the studies included and wrote the first draft of the manuscript. MG-B, MB, and CV-V gave feedback on and made adjustments to this draft. All authors, including the IGNACE group, read and approved the final manuscript. This review was conducted at the initiative of and coordinated by the Clinical Investigation Unit "Behavioral Addictions/Complex Affective Disorders" of the University Hospital of Nantes.

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SUPPLEMENTARY MATERIAL

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The Experience of Couples in the Process of Treatment of Pathological Gambling: Couple vs. Individual Therapy

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Context: Couple treatment for pathological gambling is an innovative strategy. There are some results supporting its potential effectiveness, but little is known about the subjective experiences of the participants.

Objective: The aim of this article is to document the experiences of gamblers and their partners participating in one of two treatments, namely individual or couple.

Method: In a study aiming to evaluate the efficacy of the Integrative Couple Treatment for Pathological Gambling (ICT-PG), couples who were entering specialized treatment for the addiction of one member who was a pathological gambler were randomly assigned to individual or ICT-PG. Nine months after their admission to treatment, gamblers and partners ($n = 21$ couples; $n = 13$ ICT-PG; $n = 8$ individual treatment) were interviewed in semi-structured interviews. A sequenced thematization method was used to extract the major themes.

Results: This study highlighted five major themes in the therapeutic process noted by the gamblers and their partners mainly after the couple treatment but also partly through the individual therapy. These were: (1) the gamblers' anxiety about having to reveal their gambling problems in couple therapy; (2) the wish to develop a mutually beneficial understanding of gambling and its effects on the partners in the two types of treatments; (3) the transformation of negative attributions through a more effective intra-couple communication fostered by the couple therapy; (4) the partners' contribution to changes in gambling behavior and prevention of relapses, which were both better supported in couple therapy; and (5) the interpersonal nature of gambling and its connections with the couples' relationship. However, gamblers who were in individual treatment were more likely to mention that their partners' involvement was not necessary. Participants likewise made a few recommendations about the conditions underlying the choice of one treatment method or the other.

Discussion: Participants reported satisfaction with both treatment models, but their experience was more positive in couple treatment. Complementary benefits emerged from each form of treatment, which points to future treatments involving both types. Future research should explore both the couple processes associated with attempts to stop pathological gambling and the various ways of involving partners in the gamblers' treatment.

Keywords: pathological gambling, gambler, treatment, couple treatment, couple

INTRODUCTION

The prevalence of adults with gambling problems around the world is estimated to be 2.3% (Williams et al., 2012). This difficulty in controlling one's gambling habits leads to considerable negative consequences for pathological gamblers (PG) (Shaffer and Korn, 2002; Lorains et al., 2011), but also for their family members, and in particular for their partners[1] (Ciarrocchi and Reinert, 1993; Kourgiantakis et al., 2013). Partners report high levels of psychological distress, feelings of anger, fear, loss of security (Dickson-Swift et al., 2005; Kalischuk et al., 2006; Kourgiantakis et al., 2013). They also report many physical symptoms such as headaches, insomnia, stomach problems (Lorenz and Shuttlesworth, 1983; Lorenz and Yaffee, 1988; Dickson-Swift et al., 2005). Gambling habits also entail considerable financial burden, which the partner often has to bear (Dickson-Swift et al., 2005; Hing et al., 2013; Mathews and Volberg, 2013). Finally, the couple is affected considerably, in several respects: less dyadic functioning, sexual difficulties (Trudel et al., 2008), presence of conflicts (Tepperman and Korn, 2006; Dowling et al., 2009; Kalischuk, 2010) and communication problems (Lee and Rovers, 2008; Trudel et al., 2008). Moreover, the presence of lies is a common reality in the interaction with a PG (Dickson-Swift et al., 2005; Patford, 2009; Downs and Woolrych, 2010; Hing et al., 2013), leading to a loss of confidence and a sense of betrayal felt by the partner (Dickson-Swift et al., 2005; Hing et al., 2013).

Despite the many consequences for gamblers, only a small proportion of PG (3–19%) ask for formal help, begin treatment, and partake in meetings of Gamblers Anonymous, whether this be in the last year (Slutske, 2006; Slutske et al., 2009) or during their lives (Suurvali et al., 2008). What is more, many gamblers quickly drop out of the therapy process after beginning treatment (Melville et al., 2007; Giroux et al., 2015).

Even though there are numerous negative consequences for the partners, the current treatment models, often based on individual intervention, make little or no room for them in the rehabilitation of gamblers. Several authors however, particularly in the field of drug and alcohol abuse, point to the relevance of integrating family members in the treatment (Bertrand et al., 2008; Tremblay et al., 2009). Indeed, studies in the addiction field have shown that the involvement of partners in treatment improves treatment entry (Manuel et al., 2012; O'Farrell and Clements, 2012), enhances retention, the achievement and maintenance of sobriety, and relationship satisfaction, and reduces domestic and family violence (McComb et al., 2009; Klostermann et al., 2011; McCrady, 2012; O'Farrell and Clements, 2012).

As of yet, there is little data allowing us to understand the role that partners play in the rehabilitation of pathological gamblers. Nonetheless, the few studies that have examined the role of family members have also mentioned the added effectiveness in terms of the treatment retention rate when the partners participate in the pathological gamblers' therapy (Ingle et al., 2008; McComb et al., 2009). It would seem, moreover, that a better access to social support is associated with a reduced probability of relapse in pathological gamblers (Oei and Gordon, 2008) and an improved outcome (Petry and Weiss, 2009). University of Calgary team adapted the Community Reinforcement Approach and Family Training (CRAFT) model (Meyers et al., 1996) for pathological gambler partners (Makarchuk et al., 2002; Hodgins et al., 2007; Nayoski and Hodgins, 2016). They reported partners well-being improvement and a higher probability of getting the PG into treatment. Some clinical articles have likewise reported the value of integrating the partners of these gamblers in their treatment without having objectively documented this (Steinberg, 1993). In reaction to the predominance of individual treatments (Kourgiantakis et al., 2013), we developed (Bertrand et al., 2008; Tremblay et al., 2015) like a few other research teams, couple therapy models to try and better understand the influence of partners (Ciarrocchi, 2002; Lee, 2002; Lee and Rovers, 2008). These few studies, limited due to the number of participants, seem to indicate that couple therapy improves the treatment retention of pathological gamblers, as well as being more effective than waiting list controls (Lee and Rovers, 2008; Lee and Awosoga, 2015). No studies have, as of yet, compared couple treatment with individual or group treatment.

While the initial quantitative research results lead us to think that the partners' integration has an objective and positive impact on treatment success, no study has yet explored the gamblers' and their partners' viewpoints about the perceived benefits of this form of treatment. More knowledge of these couples' perceptions would allow us however to better understand the processes involved in treatment and to estimate, from a perceptual view, the dimensions and relational underpinnings that should be

[1]In the present article, the terms *gambler, pathological gambler, spouse,* and *gambling spouse* all refer to the same member of the couple, namely the person with the pathological gambling problem. For most part, this person was male, and thus masculine pronouns are used in this article to refer to this person. Conversely, the term *partner* refers to the non-gambling member of the couple, for the most part female. Pronoun gender follows accordingly.

targeted in a couple-based treatment model. The qualitative data, as limited as it is, points to the presence of various deficits in the relationships of couples where one is a pathological gambler (e.g., communication difficulties, little intimacy, little time spent together, over- vs. under-involvement in family responsibilities) (Lee, 2014). The consequences of gambling behavior seem to aggravate these deficits by reviving old wounds, accentuating emotional reactivity, and creating a relational imbalance through an increase in shame and guilt on the one hand and control and hypervigilance on the other (Lee, 2014). The rehabilitation of gamblers who live with their partners is part of a relationship process that takes each person's life into account, establishing a climate of trust (that repairs the damage caused by the lies and betrayal) and employing constructive communication (as opposed to attacks) that permit, among other things, a discussion about the triggers that provoke the gamblers' cravings (Lee, 2015).

Current knowledge of the rehabilitation process and, more specifically, of the rehabilitation elements associated with the couple is limited and scarce. Consequently, documenting clients' perceptions of these processes may be prove to be valuable in designing and implementing new treatments, such as couple therapy. The aim of the present study was to document the experiences of the therapy process for pathological gamblers and their intimate partners, who were randomized for individual or couple treatment. The perceptions and opinions of the gamblers and their partners about the treatment they received were then collected.

METHOD

The participants were recruited as part of a larger longitudinal research project whose main objective was to evaluate the effectiveness of couple treatment (Integrative Couple Treatment for Pathological Gambling–ICT-JP) (Tremblay et al., 2015) as compared to the usual (individual) form of treatment. To be admissible to the research project, the couple had to be living together for at least 6 months and be 18 years old or over. One of the couple members had to be diagnosed as being a pathological gambler as measured by WHM-CIDI (Kessler and Üstün, 2004) and to have requested help from one of the seven addiction treatment centers in the Province of Quebec participating in the study. Both members of the couple could not have alcohol and drug abuse problems as assessed with the DEBA-Alcohol and Drugs (Tremblay et al., 2016). Income was assessed through a house-based sociodemographic questionnaire providing income categories. Gambling behaviours were recorded as a frequency and money lost, by activity and total. The financial losses du to gambling were transformed into percentages of personal and couple annual income. Psychological distress was evaluated with the IDPESQ, a 29 items scale questioning about anxiety, depression, anger, somatization and cognitive difficulties and largely validated among Quebec population (Préville et al., 1992). The four items version (Sabourin et al., 2005) of the Dyadic Adjustment Scale (Spanier, 1976) was used as a well validated short scale of marital satisfaction.

The participants in the qualitative part of the project were recruited and questioned about their therapy experiences during the evaluation meeting held 9 months after admission into therapy. The number of participants was set when empirical saturation was attained (Pirès, 1997; Creswell, 2013). The data collection was conducted from June 4, 2012 to July 22, 2014[2].

Participants

A total of 21 couples, gamblers and partners, were interviewed, of which eight were oriented in individual therapy and 13 in couple therapy. The gamblers oriented in individual treatment received the usual treatment offered in the rehabilitation center in addiction while their partner were offered treatment through the family members services available at the center (mostly individual treatment, helping them to care about themselves but also including a psychoeducational part, helping partners to better understand the gambling disorder). When the couple was oriented in couple modality, the gambler, and his partner met a clinician who applied the ICT-PG (Tremblay et al., 2015). All gamblers and their partner provided a written informed consent. A certain number of participants had access to both treatment models, either because they were in therapy in the previous year before participating in the research project[3], or because, after the treatment phase of 8–12 meetings, they could ask to have access to the other treatment model if they needed to continue. Three people from the individual therapy and five people from the couple therapy were in this situation.

The gamblers were primarily men (87.5%) and their partners were women (85.7%), except for one couple composed of two women. The mean length of time they had been living together was 13.8 years (Min = 1 year; Max = 71 years; SD = 14.7). The couples' combined annual incomes were distributed over all three levels, with 28.6% having a low income ($40,000 and less), 33.3% moderate ($40,001–$100,000), and 38.1% high (more than $100,000). As regards the 3 months preceding treatment admission, close to two thirds of the gamblers reported having played video lottery terminals (VLTs), 28.6% played various casino games, 14.3% cards (poker), and 14.3% Internet gambling. During the same period, the gamblers had financial losses equivalent to 38.7% (Min = 0%; Max = 229%; SD = 60.78%) of their individual income and 22.1% of the couples' income (Min = 0%; Max = 123%; SD = 34.2%). Almost half of the gamblers (47%) and more than half of the partners (60%) reported being dissatisfied with their couple relationship (DAS-4 $\leq$ 4). At the psychological level (IDPESQ-29), 43% of the partners and 19% of the gamblers reported having experienced a high level of distress in the 7 days preceding their admission into treatment.

[2]This study was approved by three ethics committees: the Comité d'éthique de la recherche-Dépendance-inégalités Sociales et Santé Publique (DIS) of the CIUSSS of the Centre-Sud-de-l'île-de-Montréal (CÉRT-2010-112), by the ethics committee of the Université du Québec à Trois-Rivières (CER-10-156-06.13), and by the Comité d'éthique de la recherche en santé chez l'humain du Centre Hospitalier Universitaire de Sherbrooke (CHUS) (2011-284, 10-171).

[3]But not during the last 6 months before the study started.

Qualitative Interview

Semi-structured interviews of a mean length of 20.1 min (Min = 10 min; Max = 55 min; SD = 9.7; non significative differences in duration between gamblers and partners and between participants in individual or couple therapy) explored the participants' therapy experiences, the perceived effects of the therapy, the therapy elements that contributed to or hindered change, and the couples' recommendations concerning the therapy. The proposed themes proposed to participants were similar for all (gamblers and partners, couple vs. individual therapy) with minor adaptations to their specific situations. The interviews were conducted by four master students from a counseling field and were held in the treatment centers. The spouses were interviewed separately.

Qualitative Analysis

This paper presents a descriptive and interpretative qualitative study within an existing research initiative, which is a randomized controlled trial aiming to evaluate the efficacy of the ICT-PG. This study is grounded in the interpretative tradition (Giordano, 2003), where individuals make their own interpretations based on their subjective experiences of the world (Brunelle et al., 2015). Specifically, a descriptive phenomenological approach (Giorgi, 1997) guided the development of the interview guide and the analysis process. Descriptive phenomenology focuses on exploring how human being give sense of to this experience and how he describes, perceives this experience (Patton, 2002). At the end of the analysis, the researcher can state that actual experiences gathered from the individuals involved come from their own experiences and not from objective accounts of what truly happened (Giorgi, 1997). Accordingly, we took note of participants' descriptions of their experiences without forcing the meanings of their interpretations into our own categories.

On a technical point of view, sequenced thematization (Paillé and Mucchielli, 2012, 2016) was used in this study. This type of analysis makes it possible to extract themes and sub-themes from the interviews so as to summarize the collected statements (Paillé and Mucchielli, 2012, 2016). To do so, different stages were carried out during the analysis. To begin with, all the audio recordings were integrally transcribed by three research assistants. Themes and subthemes began to emerge after the reading of a few randomly selected interviews (four protocols, i.e., one partner and one gambler in individual therapy, and one partner and one gambler in couple therapy). These were integrated into a coding table created by one of the project researchers together with the research assistants in charge of codifying the interviews. This coding table represented a thematic concept tree with a description specific to each theme and sub-theme so as to ensure that the whole research team had a uniform understanding of the concepts. Subsequently, two research assistants codified the remaining interviews using this coding table. Since two people codified the interviews, three interjudge agreement processes were conducted during the analysis. A total of six interviews were codified by two assistants and the classification differences were discussed so as to ensure coding uniformity. This coding work was conducted under the supervision of the main researcher and used the qualitative data analysis software *QSR International NVivo 9*. Once the whole corpus was codified, the two research assistants created a summary for each of the codified hubs. A comparison of the participants' statements as a function of the treatment modality received by participants was conducted.

RESULTS

The analysis of the participants' statements drew out several crucial themes from the overall changes that occurred, in the participants' eyes, due to the treatment they received. Most of the themes were shared by the gamblers and their partner in the same treatment modality but many themes differentiated couples in the two modalities (see **Table 1**). The participants also described the different ways that the treatment enhanced their efforts to make progress in various aspects of their lives.

1. **Revealing gambling behaviors to the partner**
   All gamblers noted that one of the delicate tasks of the change process was to be honest about their gambling cravings and behaviours, in particular toward their partner. Some gamblers reported not wanting to reveal everything to their partners, this being all the more true for those for whom lying was a well-established behavior.

   > *"Sometimes it's better your girlfriend doesn't know certain things. They're not really lies, they're personal things you don't want her to be aware of." [5191-Gambler_CoupleTherapy[4]]*

   > *"When you are an addict, whether it's alcohol, gambling, or drugs, you're a liar too. [So, your partner] she doesn't really know [what you do]." [14331-Gambler_CoupleTherapy]*

   Gamblers in the two types of treatment mentioned this point, emphasizing how individual treatment was better in this regard than the couple format, which did not encourage gamblers to reveal everything to their partners.

2. **The need to develop mutual comprehension and the need for help to attain it**
   As opposed to the preceding theme, several couples emphasized both their need to mutually understand each other and their need for help to achieve this. They had the impression that they lacked the communication skills to talk about the difficulties caused by gambling.

   > *"Our ways of expressing ourselves and understanding each other weren't very good. [. . .] He didn't really understand what I was trying to say, and I didn't understand him either." [16310-Partner_CoupleTherapy]*

[4]Each interview verbatim citation is identified by (a) a unique number to each individual, (b) the status of the participant as a gambler or a partner, and (c) the modality of treatment received (individual therapy, couple therapy or even both for a few exceptions).

TABLE 1 | Themes reported by participants in function of treatment modality received and status (i.e., gambler vs. partner).

Themes	Individual therapy		Couple therapy	
	Gambler	Partner	Gambler	Partner
1. Revealing gambling behaviors to the partner	x		x	
2. The need to develop mutual comprehension and the need for help to attain it				
a) The partner's need to understand the change process	x	x	x	x
b) The need to have discussions about their mutual experiences	x	x	x	x
c) The benefits of having a neutral person present			x	x
d) The practice of communication			x	x
3. Better mutual comprehension improves mutual support				
a) The couple approaches the gambling problem together			x	x
b) No longer reinforce gambling behavior			x	x
c) Gambling behavior interpreted as meanness			x	x
d) Gamblers develop a better understanding of their partners' suffering			x	x
e) The partners help the gamblers to avoid relapses			x	x
f) The couple starts to do enjoyable activities together again			x	x
4. Commitment to and regularity in treatment	x	x	x	x
5. For many, gambling is a relational problem	x	x	x	x
6. In some gamblers' opinion, gambling does not concern the couple	x			
7. Format and structure	x	x		x
8. Conditions favouring one treatment or the other				
a) Conditions favouring individual treatment	x	x		
b) Conditions favouring couple treatment			x	

a) The partner's need to understand the change process

A first demonstration of the necessity to develop mutual comprehension was the need expressed by the partners from both modalities to grasp what was going on in the minds of the gamblers vs. the potential difficulty of the gamblers to talk about their progress in the therapeutic process.

These needs did not seem to be responded in the individual treatment. Partners from this modality stated that they noted changes in the gamblers during the therapy process but that they did not understand why the latter engaged in excessive gambling behavior. This lack of information led them to be suspicious of the gamblers, to not believe what they said.

> *"I would like to have known why… What was going on in his head. […] I had a hard time believing what he told me. I would have liked [to know] if the meetings were having an impact on him, to reassure me." [16230-Partner_IndividualTherapy]*

Furthermore, gamblers in individual treatment reported how difficult it was for them to tell their partners what they had said during the therapy sessions, either because they did not wish to share it or because they had a hard time finding the right words.

> *"When I consulted individually [this gambler had individual treatment during the years before actual project participation], I didn't tell my partner what happened during the meetings. It was already intense enough in the meetings, so I left it there. [At the time I said to myself]: It's my problem, so why involve him." [3380-Gambler_CoupleTherapy]*

> *"Your partner doesn't know what you're working on to get through it. She's not doing it. You can try and explain it to her after [the individual meetings] at home, but it's not the same." [16161-Gambler_IndividualTherapy]*

At the opposite, couple treatment helped partners to better understand underlying gambling motivations and gamblers to talk about their inner experience concerning gambling urges and behaviours.

> *"Gambling is difficult to understand by a partner. […][Couple therapy] helps partners to understand gambler's problem and gamblers to explain gambling behaviours to the partner" [3240-Partner_CoupleTherapy]*

b) The need to have discussions about their mutual experiences

Both members of the couple mentioned the need to have time to talk about themselves mutually and respectfully,

so as to more clearly express their emotions and ideas and better understand the other person's.

Couple treatment seemed to genuinely provide a moment for respectful exchanges that were more difficult to have at home. The couple meetings obliged them to stop, listen to each other, and talk about themselves, which did not seem to occur otherwise.

> *"With the therapist, [my husband] doesn't have the choice but to let me finish my sentences […], to listen right to the end. […] At home, he would have listened to half the sentence [and] then filled in the rest." [3240-Partner_CoupleTherapy]*

Partners and gamblers in individual therapy likewise reported that they would have liked to have taken part in couple therapy to benefit from the organized exchanges.

> *"I would have liked that [couple treatment] […], it seems more helpful. You are both there, you can hear what the other person has to say […], we could have had a real discussion for once." [14410-Partner_IndividualTherapy]*

> *"Well, to be honest, we wanted to be together [in couple therapy] because we wanted to understand. But now that we're in individual treatment, I find it a bit… disappointing." [16230-Partner_IndividualTherapy]*

c) The benefits of having a neutral person present

The presence of a therapist with a neutral attitude facilitated constructive communication. The therapist helped the couple to talk honestly about themselves to their partners, but also to listen sincerely. This idea was mentioned only by couple therapy participants.

> *"It's a lot easier with a neutral person, you feel like you have to tell the truth about what you're feeling, about what the other person is putting you through." [3260-Partner_CoupleTherapy]*

d) The practice of communication

The therapist also helped the couple to express what they were going through, to find the words to describe what they were experiencing and feeling, but also to ensure that they listened carefully to each other. Several couples oriented in couple treatment mentioned communication strategies established by the therapists during the meetings, including: the right to speak and the need to listen, rephrase, clarify, elaborate, and use words better suited to a constructive exchange. The mediation skills seemed to help the couples to talk about themselves better, listen better, and thus understand better.

> *"It made me realize […] I should double check on what my wife thinks. […] I mean, did I understand her, [tell her] what I understood, then wait for the answer. Sometimes I think [I've understood and] that she's understood, but perhaps we haven't really understood each other at all." [14331-Gambler_CoupleTherapy]*

Some gamblers and partners mentioned how they progressed in their ability to speak about themselves because of the couple treatment. Moreover, talking about oneself in front of one's partner allowed the participants to immediately grasp the reaction of the other and thus improve their mutual understanding.

> *"I'm not a very talkative guy, but here, I have to talk about myself, […] about my feelings. I've never done that before. For sure [couple treatment] helped me to learn how to talk more about myself and be more open-minded." [16211-Gambler_CoupleTherapy]*

> *"I think you solve more communication problems right away by saying straight out [what you think], face-to-face." [14371-Gambler_IndividualTherapy_CoupleTherapy]*

3. Better mutual comprehension improves mutual support

The fact of better understanding the other person's psychological experiences often led to an increase in empathy and greater tolerance. All the ideas included in this third global theme were mentioned only by the gamblers and partners oriented in couple treatment.

a) The couple approaches the gambling problem together

The partners in couple therapy understood their gambling spouses better and, for some, a discussion began around the theme of gambling and gambling cravings that lasted all week long, thereby creating a place for discussion that extended beyond the treatment meetings.

> *It's as if the meetings lasted longer […] because there's one whole hour here, but then there's all those short moments [where we talk] during the week. It's like it's teamwork. [3380-Gambler_CoupleTherapy]*

Some gamblers also had the impression that their partners, because of their physical and emotional proximity, became a more accessible resource than the therapist when they had strong gambling cravings or even relapses. By better understanding the causes of the spouses' gambling behavior, the partners were in a better position to help them.

> *"She had already come for individual treatment. Even though she talked to me about her gambling problems, I think I didn't have the right tools to understand her completely. But coming to couple treatment has given me the tools I needed to understand her, talk about it, and help her so it doesn't start again." [3381-Partner_CoupleTherapy]*

b) No longer reinforce gambling behaviour

The partners who came to the couple meetings reported having learned how to reduce the situations that stimulated their spouses' gambling cravings, while at the same time stating that it was difficult to achieve.

> *"You always have to be careful. I don't buy any scratch and win [tickets]. […] And I'm always watching over people*

who [might cause a relapse]. But it's not easy to do." [3240-Partner_CoupleTherapy]

c) Gambling behaviour interpreted as meanness
The partners frequently perceived gambling behavior as a mean and spiteful action by the gamblers, or as an absurd, meaningless behavior.

"Because, most of the time, [you say] 'How can you do that? Come on, that's crazy? You've got a brain, you can stop [gambling].' It's difficult to understand for a person who doesn't have the problem." [3240-Partner_CoupleTherapy]

A growing, mutual understanding helps them to modify this perception and to see the suffering underlying gambling behavior. Through couple treatment, a better understanding helps the partners not to attack and belittle their gambling spouses so often, and to try to support them in the rehabilitation efforts. The gamblers clearly highlighted this issue and considered that the perception of meanness was erroneous.

"She didn't understand gambling at all. She thought everything could be healed, that only crazy people gamble. [Now] she has another perception, [she] understands what happens to me, that I don't go because I feel like gambling all our money. [. . .] Now it's easier for her to support me rather than just shouting and killing me." [5191-Gambler_CoupleTherapy]

"My wife, she thought I wanted to hurt her but that wasn't it at all. Gambling is stronger than I am, I go even though I know I shouldn't." [16311-Gambler_CoupleTherapy]

d) Gamblers develop a better understanding of their partners' suffering
The gamblers did not always realize the impact of their gambling behavior on their partners. The couples' therapy meetings helped to increase this understanding, which relieved the partners.

"He [my gambling spouse] looked at me [. . .] and said 'I didn't know that it hurt you so much and that you were that scared.' It was as if he had never realized." [3260-Partner_CoupleTherapy]

e) The partners help the gamblers to avoid relapses
The partners helped to create an environment in which their spouses' gambling cravings and behaviors were not encouraged. They did this by remaining vigilant about preventing potential gambling stimulations, including such things as time spent with gambling friends. The gamblers sometimes mentioned how much they needed their partners' support to maintain what they had achieved.

"I have a disease that will always be there. She knows that the support she gives me is very important [which means that] now I only gamble very rarely or almost never. Now she understands her importance to me, and me to her too. Now we're important for each other." [14371-Gambler_IndividualTherapy_CoupleTherapy]

f) The couple starts to do enjoyable activities together again
Several participants in the couple therapy mentioned that they had stopped participating in simple couple activities (e.g., going to the movies, holding hands) or more elaborate ones (e.g., travel), but that they had started doing them again, realizing the pleasure it added to their relationship.

"We've been together for 24 years and we've never held hands [saying] 'I love you' and things like that. So now we've learned to do it." [3180-Gambler_CoupleTherapy]

4. Commitment to and regularity in treatment
The couples in both treatments raised the issue of the gamblers' motivation, particularly the need to help them go to treatment regularly. The gamblers' motivation to reduce their gambling habits and thus to continue attending the meetings had to be encouraged by the partners, a fact that was noted by both the gamblers and their partners.

Couple therapy is perceived as more helpful than individual one to sustain regularity in treatment. Several of the gamblers selected for couple treatment mentioned that, if it had not been for the presence of their partners, they would not have continued the treatment. The fact of making a commitment to their partners and feeling supported by them was of considerable importance. Partners who participated in the couple treatment were of the same opinion.

"I don't know if I would have made it to the end. Sometimes it takes a little kick in the butt. I don't know if I would have had the motivation to come every time, it's easier to do it together. [. . .] Sure I'm the one who has the problem, [but with] someone to support you all the time, it's a bit easier." [5191-Gambler_CoupleTherapy]

"I also made a commitment to my partner in that [couple] therapy. It wasn't just a promise to myself, I think it meant more to me to have to commit [to] both of us to no longer gamble." [3380-Gambler_CoupleTherapy_IndividualTherapy]

Similarly, the partners of the gamblers who were in individual treatment considered that their gambling spouse would have gone more regularly to treatment meetings and thus would have made better progression if they, the partners, had gone to the same treatment meetings.

"If we had been in couple treatment together, it would have certainly lasted longer. He would probably have gone right to the end [of the treatment]. Even if I had to drag him on a leash [to the meetings]." [14280-Partner_IndividualTherapy]

5. For many, gambling is a relational problem
Several couples in both treatments considered that gambling problems were intertwined with the couples' relationship and that it was therefore necessary to discuss everything during the couple meetings. For these participants, opting for couple

treatment was an obvious choice, responding more directly and effectively to the gambling problem and its relationship dimension.

> *"The couple is the problem. If you gamble [. . . the problem] is in the family too. You don't have any more [money], you don't spend anymore [for the family], you keep it up, you always go out alone. I think couple therapy is better for bringing the two together, we'll solve the problem together." [16271-Gambler_CoupleTherapy]*

> *"Yeah, it's important. Sure, I'd recommend [couple therapy], because I don't think it can work all alone. It can't, it's not the same thing. I can't say to my spouse, "Fix your problem [yourself], [because] it's our problem. We live together for better or for worse, so it's our problem." [3260-Partner_CoupleTherapy]*

Furthermore, these couples reported that the gambling problems caused the partners considerable suffering and that couple treatment made it possible to help both members of the couple.

> *"I think all couples would be better off doing the couple therapy. Because I think the person living with someone who has a [gambling] problem suffers as much as the gambler. You help two people in difficulty. Two birds with one stone." [16311-Gambler_CoupleTherapy]*

6. In some gamblers' opinion, gambling does not concern the couple

Inversely, some gamblers oriented in individual treatment considered that they were much better off in individual treatment, believing that their partners would have wasted their time in these meetings. They did not want to talk to their partners about their personal difficulties. Couple therapy would only have been useful for dealing with relational conflicts. No gamblers in couple therapy expressed this opinion.

> *"[If I was going to couple therapy], we'd really have to come to an agreement about the fact that I need to talk without her being there. [. . .] I think [couple therapy] it's not the place to talk [about more personal difficulties]." [3441-Gambler_IndividualTherapy]*

7. Format and structure

Most of the couples were satisfied with the services received, whether it was the individual or couple therapy. A few people who were selected for individual treatment and subsequently received couple therapy, considered that a combination of the two types of treatment would have been beneficial, beginning with individual meetings and then working with the couple. The partners mentioned that this would have allowed them to speak more openly during the individual treatment without running the risk of hurting the gambling spouses. What is more, when the partners obtained services through the family members services (only for couples randomized to individual therapy), there was a teaching section in the individual therapy where the partners learned about the psychology of gamblers, how pathological gambling develops, and all the various elements that would help them understand their gambling spouses. Subsequently, the couple meetings allowed them to talk about relationship problems.

> *I think it's important the partner learns what it means to be a gambler, what his strategies are, everything surrounding gambling. Then she'll be more prepared for couple meetings, it'll be easier to understand what her [gambler] spouse is saying. To be able to say what we really want to say without being afraid of hurting the other person, of pushing him to gamble more. [. . .] Individual treatment followed by couple treatment, I think that would be perfect. Individual is okay, but [at] some point, you absolutely need couple treatment. [14370-Partner_IndividualTherapy_and_CoupleTherapy]*

The gamblers oriented in individual treatment agreed for the most part that it would have been too difficult to begin with couple meetings. They would have had the impression of not being able to speak freely, of feeling "tense." They thought however that, after having taken the time to straighten out their personal situations, it would have been beneficial to continue with couple meetings.

> *"Begin in individual, work on some things, then after, do some couple therapy. I'd suggest that to lots of people. If I had begun in couple, things would have seized right up. It wouldn't have helped me. If you can, do individual for a while like I did, then after jump into couple therapy. Cause then, you've worked on problems, you've understood some things that you wouldn't have understood [in couple treatment]. Individual helped me to get some of the bad things out, to understand stuff. Then you go to couple treatment and you can go farther." [3441-Gambler_IndividualTherapy]*

8. Conditions favouring one treatment or the other

The participants wanted to talk about the conditions favouring orientation to individual or conjugal treatment.

a) Conditions favouring individual treatment

In situations where the gamblers had great difficulty expressing themselves and where the partners talked a lot and even too much, it might be better to direct the gamblers toward individual treatment, and this in the opinion of one partner who considered she talked too much.

Furthermore, when gamblers did little to meet the family's needs and invested little in the couples' relationship, their partners felt relieved to know their gambling spouses were consulting individually, as this gave them the impression they had a bit less to carry on their shoulders. The partners felt that they had to overcompensate for their spouses' passiveness. The fact that the gamblers themselves asked for help thus represented a step toward their self-sufficiency and a lightening of the partners' own excessive load in family tasks and chores.

> *"That [the fact he is going to individual therapy] has lightened my load. Because he depends a lot on me to get through life. So, the fact that I didn't have access [to his therapy] let me relax. I had one less worry. Somebody else was taking care of him. It took a load off my shoulders, gave me one less thing to take care of in his rehabilitation process. Before I had all the responsibilities because he refused to take any. It's easy to delegate everything to your wife; when you don't take on any responsibilities, you can't be blamed for anything. Now when the telephone rings because this or that happened, I don't worry about it. He has to take care of it." [14280-Partner_IndividualTherapy]*

Other couples mentioned that individual treatment allowed them to progress at their own rate by, among other things, adapting the frequency of the meetings to their personal needs.

In situations where the gamblers had to explore different elements of their childhood or adolescence, it was sometimes advantageous to turn to individual treatment, thereby giving the gamblers all the space they needed to talk about themselves freely.

b) *Conditions favouring couple treatment*

One gambler who took part in the couple treatment mentioned that, to be selected, the couple already had to have a trusting relationship. He reported that his therapeutic progression has led to make connections with his childhood, consequently revealing part of his personal history to his partner. He reported how the wish to create a strong couple relationship was a very helpful tool to embark on pathological gambling treatment as a couple. Other more shy gamblers mentioned that their partners presence made it easier to open up before the therapist. They felt that being alone with the therapist would have made it more difficult to talk about themselves.

Other gamblers clearly recommended couple treatment when the gamblers wanted to save their couple relationship. Mutual understanding fostered reciprocal support whereas individual therapy risked resulting in a breakup.

> *"If the person doesn't care for his partner, [let him] do it [the treatment] all alone. But if you want your relationship with your wife to survive, I think it's better to involve the other person who's in it. That way, she can understand you better, and then she'll be able to help you. And so will you, you'll understand things too." [14331-Gambler_CoupleTherapy]*

DISCUSSION

This study, which to our knowledge is the first to document and compare gamblers and their partners who have received either individual or couple treatment for pathological gambling, helps us to better understand the therapeutic processes in play, as well as to determine the issues involved in choosing between the different types of treatment. Even though the impacts of pathological gambling on couples have been well described in various quantitative studies (Trudel et al., 2008), these couples' experiences in gambling rehabilitation and the therapeutic process have gone largely unexplored. That being said, we must take these experiences into consideration if we are to develop and improve treatment for pathological gambling that takes into account the couples' personal situations and needs.

This study highlighted five major themes in the therapeutic process noted by the gamblers and their partners after the individual or couple treatment, namely: (1) the gamblers' anxiety about having to reveal their gambling problems in couple treatment; (2) the wish to develop a mutually beneficial understanding of gambling and its effects on the partners in the two types of treatment; (3) the transformation of negative attributions through a more effective intra-couple communication fostered by the couple therapy; (4) the partners' contribution to changes in gambling behavior and prevention of relapses, which were both better supported in couple therapy; and (5) the interpersonal nature of gambling and its connections with the couples' relationship. Moreover, the participants made a few recommendations as to the conditions which helped to choose one type of treatment or the other.

The impact of pathological gambling on couples was different according to the viewpoint, namely that of the gambler or partner. Regardless of the treatment received, the gamblers spoke of the difficulty of talking about themselves in front of their partner, and even more so of talking about their gambling behavior. Indeed, numerous authors have reported how gamblers constantly lie to their partners (Lorenz and Yaffee, 1989; Dickson-Swift et al., 2005). Gambling behavior is relatively easy to hide given that it leaves no physiological traces (McComb et al., 2009). Gamblers are aware of the potential negative impact of their deception on the quality of the couple relationship and are thus afraid of losing their partners' trust and arousing their anger. The gamblers' dishonesty is reported as one of the main causes of tension and conflict in couples' relationships (Blaszczynski et al., 1999; Dickson-Swift et al., 2005). These were probably the issues in the present study that led gamblers' to mention that individual treatment allowed them to reveal more of themselves than did couple treatment. Moving from a period of constantly lying to one's partner to one of telling the truth is certainly not simple and produces considerable apprehension in gamblers. As for the partners, they largely expressed the need to develop better mutual understanding, a need that was shared by the gamblers, and this despite their apprehensions.

On the one hand, the partners, having been confronted for years with the dissimulation of gambling habits, found it difficult to understand the reasons that pushed the gamblers to such extreme behavior. They consequently tried to shed light on the situation. On the other hand, the gamblers reported not knowing how to talk to their spouses about their progress when they were in individual therapy. Other qualitative studies have reported on these communication difficulties (Lee and Rovers, 2008; Trudel et al., 2008), which comprise such patterns as negativity, unproductiveness, blame, avoidance, and withdrawal (Lee, 2002). Participants in couple therapy reported how this treatment type helped them to develop their communication

skills, primarily through the presence of a neutral, third person but also through exercises that were practiced during the meetings. Some of the participants in the individual treatment mentioned that they would have liked to try the couple treatment. By mentioning the crucial role of the therapist, the participants were indirectly referring to the concept of the therapeutic alliance. This, in the context of couple therapy, includes the notion of a safe climate created by the therapist as a fundamental element which allows both members of the couple to talk about themselves without fear of being counterattacked (Beck et al., 2006). The results of a meta-analysis found moreover that therapeutic alliance in a couple treatment showed a moderate effect size as to the prediction of the treatment's effectiveness (Friedlander et al., 2011). Given that lying, but also anger and the desire for vengeance are common in couples where one member is a pathological gambler, a safe, neutral climate where each person can be equally heard (Boszormenyi-Nagy et al., 1991) allows people to express themselves and listen to the other person talk about fundamental relationship issues.

Tepperman and Korn (2006) had previously noted that a better couple relationship was associated with greater interest on the part of gamblers to modify their gambling behavior. The results on the opinions of couples who received couple treatment made it possible to better document the processes leading to a higher probability of the gambler changing. These couples reported how better communication fostered greater mutual empathy and improved the quality of the relationship. On the one hand, the partners modified their attributions, perceiving fewer malicious intentions in the gambling behavior. On the other hand, the gamblers were more aware how much their gambling behavior hurt their partners. These research results indicate that the partners' realized that the gamblers' poor behavior was not an indication of a deliberate wish to hurt the partners, thus making reconciliation easier (Hook et al., 2015). Gender-based differences have been noted where, in women, changes in attributions helped them to forgive their spouses, whereas in men, more empathy toward the wives increased the men's ability to forgive them (Fincham et al., 2002). It is not surprising that the theme of a change in attributions was present in the statements of couples who received couple treatment, since gamblers' excessive behavior is a good example of relationship trauma. Their behavior violates the partners' expectations and beliefs about an attachment relationship, and, in so doing, destabilizes the partners' feeling of security by undermining their ability to predict future behavior (Gordon and Baucom, 1998). The concept of forgiveness, used in several studies exploring relational trauma in couples (Greenberg et al., 2010), presents several similarities with the processes evoked by the participants, for example, the changing of negative feelings (anger, feelings of vengeance) into greater attachment and empathy (Malcolm et al., 2005) and the acquisition of a more realistic view of the spouses (Gordon and Baucom, 1998). It would seem worthwhile to further pursue research into the role of forgiveness in couples where one member is a gambler. Studies should focus on the therapeutic strategies that best facilitate this improvement in negative feelings, since this process of forgiveness is predominant in predicting relationship improvement after the treatment (Meneses and Greenberg, 2014). Furthermore, it would seem to be difficult to embark on a forgiveness process without outside help (Ferland et al., 2017).

Many of the participants in couple treatment reported on how the partners were able to help the gamblers avoid relapse. This observation contradicts those of another study conducted with gamblers and their partners who were not in treatment, the study revealing that most of them thought that the partners could not influence the gamblers' behavior (Tepperman and Korn, 2006). Several studies have noted that the partners sometimes had non-intentional behavior that favored gambling (Bertrand et al., 2008), one of these being relationship tensions associated with the partners' control of the money (Lorenz and Yaffee, 1989). As regards substance abuse, the partners were asked to do the following: increase behaviors that were identified as favouring abstinence (e.g., avoid exposure to substances or at-risk situations), to decrease those that inadvertently favored substance use (e.g., protect the addict from the natural negative consequences of substance use) and be actively available to talk about difficult situations or other aspects related to reduction (Meyers and Smith, 2009; O'Farrell and Clements, 2012). Clinical articles (McGurrin, 1992) and studies (Krishnan and Orford, 2002) that have focused on pathological gambling would seem to point in the same direction, noting that partners reimbursed debts, apologized to bosses for work absences, and took charge of negotiations with creditors, thereby potentially fostering continued gambling behavior. The statements of the participants in the present study, specifically those in couple treatment, tended to confirm these hypotheses, namely that partners can help gamblers stop gambling and avoid relapses. They likewise pointed out that the partners played a "supervisor" role in avoiding relapse and providing more enjoyable couple activities with no connection to gambling.

Several participants underlined the intrinsically relational aspect of gambling behavior problems, thus emphasizing the need for the partner to be involved in the treatment. This observation was probably at the basis of the participants' considerable satisfaction with the couple treatment and the interest of several of the participants in individual treatment to participate in the former. This emphasis on the relationship aspect in pathological gambling is commented on by numerous authors who highlight the considerably negative impact that gambling has on the partners and the family (Dickson-Swift et al., 2005; Ferland et al., 2008; Kourgiantakis et al., 2013). Gambling erodes trust and provokes depression and anxiety in the family (Ferland et al., 2017), and leads to less quality time spent together and poorer communication (Dowling et al., 2016; Ferland et al., 2017). This relationship dimension could also be seen in the benefits arising from involving family members (Ingle et al., 2008), in the pathological gamblers' treatment, particularly the partners (Lee and Awosoga, 2015). However, a few participants, primarily gamblers who had taken part in individual treatment, considered that the spouses were not concerned by what was discussed in treatment and that they would be wasting their time. These statements were similar to those made by gamblers

who were not undergoing treatment as well as to those of their partners (Tepperman and Korn, 2006). It would thus seem that participating in couple treatment made gamblers realize the importance of the relationship dimension in their problem, and thus the need for couple treatment that takes this into account. Among gamblers who were not involved in treatment where the spouses participated, it was more likely that they mentioned that their partners' involvement was not necessary.

The problem of gamblers dropping out of treatment early has been described as a priority subject in clinical research (Toneatto and Millar, 2004). This being said, the gamblers who were oriented toward couple treatment reported how they went to treatment more regularly because of their partners' presence. Partners whose gambling spouses were oriented toward individual treatment mentioned how they would have liked to have had more influence on the gamblers' presence at appointments, and how this would have been easier in couple treatment. Some research results have shown that the fact of living together positively influenced presence in the treatment among pathological gamblers (Aragay et al., 2015), though other results did not confirm this observation (Ingle et al., 2008). It would seem nonetheless that continuing in treatment is more likely when there is support in the gamblers' environment (Grant et al., 2004). When family actively participated in the treatment, the pathological gamblers were present more often and remained 30% longer than those who had no family members involved (Ingle et al., 2008). Even direct but minimal help provided solely by concerned significant others helped to reduce the number of gambling days and improved the quality of the relationship (Hodgins et al., 2007).

Some participants expressed an interest in an approach that would combine individual and couple treatment. No clinical trials of this type are known to have been conducted in the treatment of pathological gambling. That being said, in substance abuse treatment, a combination of individual or group treatment on the one hand and couple treatment on the other proved to be more effective than individual treatment only (O'Farrell and Clements, 2012), which opens the door to a possible combination of these two treatment types. Conversely, couple treatment in a group setting proved to be clearly less effective than standard couple treatment (in the two cases in combination with individual treatment) in work with alcoholics, highlighting the importance of evaluating the effectiveness of various ways of providing treatment (O'Farrell et al., 2016).

The participants likewise remarked on conditions that favored or hindered their participation in one type of treatment or the other. Participants in couple therapy revealed the importance of having a satisfying couple relationship at the beginning of the therapy and the wish to preserve this relationship as factors that contributed to a successful couple therapy. These statements are supported by clinical and research literature that reports how relationship stability is a plus in couple treatment for addiction (O'Farrell and Fals-Stewart, 1999). Not surprisingly, the scientific literature also shows that all the indicators of greater problem severity are identified as being associated with less successful couple treatment for substance abuse. It is likely that this also applies to couple treatment for pathological gambling. Frequently reported signs are severe consumption of drugs and alcohol, drug and alcohol related problems in both members of the couple, severe and chronic violence (Birchler et al., 2008), and mental health problems (O'Farrell and Fals-Stewart, 2006; Birchler et al., 2008). Moreover, some of the participants stated that, if the gamblers did not wish to tell their partners about all their problems, it would be better to use individual therapy or a combination of the two. Future research should try to establish criteria for directing gamblers who are in relationships toward individual, couple, or combined treatment.

The present study has some limitations. To begin with, it is reasonable to think that the people who agreed to participate in the study had a favorable attitude toward involvement of the couple in treatment, since this was one of the two types of treatment in which they would take part. It is likely that relationship issues were at the heart of the concerns of gamblers and their partners who accepted to participate in the project and that their comments would be more favorable toward couple treatment. A social desirability bias may thus have been present. Furthermore, even though this study was presented neutrally as a comparison of the two treatment types, it is possible that the participants had the impression that the researchers and clinicians favored couple treatment, and that they subsequently wanted to please the research team in their answers during the qualitative interview. Likewise, it would have been beneficial to question people pre-treatment as to their impressions about the pros and cons of each type, and then compare post-treatment their subsequent opinions about the treatment and its impact on their rehabilitation. Contrast analyses as a function of gender, the presence or not of children, and the seriousness of the gambling problems would have been interesting to explore, but the sample size was too small to permit such analyses.

CONCLUSION

The participants brought up several relationship issues that were associated with the fact that one member of the couple was a pathological gambler, and consequently insisted on how couple treatment helped them to deal with these issues and their overall situation. These statements were made by both the gamblers and partners. They were proportionally more frequent—indeed, practically unanimous—among the participants in the couple treatment, but were also made by several participants in the individual treatment group who perceived several potential benefits in the couple treatment. Conversely, the advantages of individual treatment were almost exclusively emphasized by people who partook in this treatment, which suggests that the disadvantages of the couple treatment stemmed more often from anticipatory fear rather than from actual experiences. That being said, the individual treatment did seem to have some undeniable benefits.

The participants' statements highlighted the interest and benefits of couple treatment and support the clinical relevance. The couples, one of whom was a pathological gambler, had to learn to mutually understand each other and partake in the

reconstruction of their trust. For this, they needed outside help. That said, the partners also became a source of aid during this process. These results highlight the necessity to pursue research into how couples change when one member tries to put an end to pathological gambling. For example, the dimension of forgiveness but also the trauma experienced by the partners would be worthy of special attention in future research, in couple treatment but also in individual treatment for the partners. The current results likewise highlight the necessity to evaluate the pertinence of the various types of treatment for gambling, including the different ways of involving family members. It is also worth noting the need to pursue research with clientele with concomitant problems related to substance abuse and gambling. Clinical practitioners participating in the study pointed to the regular frequency of these concomitant problems. In short, a range of treatment targeting the multiple needs of gamblers and their partners would seem to be a response that is better adapted to a complex problem like pathological gambling. Future research should look for different ways of integrating partners into the treatment.

AUTHOR CONTRIBUTIONS

JT: Co-contributions to the conception or design of the work. Co-interpretation of data for the work. Co-drafting the last version. Final approval of the version to be published. MD, KB, NB-M, FF, A-CS, MS-J: Co-contributions to the conception or design of the work and revisiting and critically the drafting. MC: Analysis and co-interpretation of data for the work. Drafting the first version. Validate references.

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Similarities and Differences between Individuals Seeking Treatment for Gambling Problems vs. Alcohol and Substance Use Problems in Relation to the Progressive Model of Self-stigma

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Aims: People with gambling as well as substance use problems who are exposed to public stigmatization may internalize and apply it to themselves through a mechanism known as self-stigma. This study implemented the Progressive Model for Self-Stigma which consists four sequential interrelated stages: awareness, agreement, application and harm on three groups of individuals with gambling, alcohol and other substance use problems. It explored whether the two guiding assumptions of this model (each stage is precondition for the following stage which are trickle-down in nature, and correlations between proximal stages should be larger than correlations between more distant stages) would differentiate people with gambling problems from those with alcohol and other substance use problems in terms of their patterns of self-stigma and in terms of the stages in the model.

Method: 37 individuals with gambling problems, 60 with alcohol problems and 51 with drug problems who applied for treatment in rehabilitation centers in Israel in 2015–2016 were recruited. They completed the Self-stigma of Mental Illness Scale-Short Form which was adapted by changing the term "mental health" to gambling, alcohol or drugs, and the DSM-5-diagnostic criteria for gambling, alcohol or drug disorder.

Results: The assumptions of the model were broadly confirmed: a repeated measures ANCOVA revealed that in all three groups there was a difference between first two stages (aware and agree) and the latter stages (apply and harm). In addition, the gambling group differed from the drug use and alcohol groups on the awareness stage: individuals with gambling problems were less likely to be aware of stigma than people with substance use or alcohol problems.

Conclusion: The internalization of stigma among individuals with gambling problems tends to work in a similar way as for those with alcohol or drug problems. The differences between the gambling group and the alcohol and other substance groups at the aware stage may suggest that public stigma with regard to any given addictive disorder may be a function of the type of addiction (substance versus behavioral).

Keywords: self-stigma, public stigma, problem gambling, alcohol use problems, substance use problems

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INTRODUCTION

One of the important changes in the Fifth Edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5: American Psychiatric Association [APA], 2013) was to include Gambling Disorder under the section on Substance-Related and Addictive Disorders for the first time (Straussner, 2013). The decision to include gambling disorder in this section reflects the acknowledgment that this disorder is comorbid with substance use disorders, and is similar to them as regards certain symptom presentations, genetic liability, biological dysfunctions and treatment approaches (Hasin et al., 2013; Petry, 2015).

However, the similarities between these disorders may not be manifested in relation to public stigma; i.e., the prejudice and discrimination directed at a group by the population at large (Corrigan and Rao, 2012). Previous studies that compared public stigma across these addictive disorders (gambling vs. alcohol and other substances) suggest that people with alcohol or substance dependence are viewed by the public more negatively than pathological gamblers (Feldman and Crandall, 2007; Hing et al., 2016b). For example, Hing et al. (2016b) asked a sample of 2000 adult residents of Victoria, Australia to read five vignettes about recreational gambling, problem gambling, alcohol use disorder, schizophrenia, and a subclinical distress control. They found that problem gambling was less stigmatized than alcohol use. Similar results were reported by Feldman and Crandall (2007) in a study exploring which mental disorders are the most stigmatized or socially rejected. Based on a sample of 270 American university students who read case histories describing individuals with 40 mental disorders, they found that out of the addictive disorders, cocaine dependence was rated as the most stigmatized disorder (rated 6th), more than alcohol dependence (rated 10th) whereas pathological gambling was rated 13th. In contrast, one study also based on a student sample (this time249 Canadian university students) who rated vignettes describing males with five different health conditions found no differences between disordered gamblers and alcohol dependence in terms of desired social distance from these disorders (Horch and Hodgins, 2008). In Israel, where the current study was conducted, an earlier study indicated that mental health professionals perceived the issue of adolescent gambling as less severe than alcohol or drug use (Sansanwal et al., 2016).

However, public stigma does not stop there since it can also be internalized (Schomerus et al., 2014). Exposure to public stigma may lead to self-stigma – a process that integrates emotional and cognitive elements – which accrues when a person applies this internalized common negative public stigma to herself/himself (Corrigan et al., 2006). Once this process occurs, the individual may exhibit negative emotional reactions such as poor self-efficacy and diminished self-esteem (Corrigan and Rao, 2012). This process also impedes treatment-seeking and recovery among individuals with gambling (Hing et al., 2016a) and other substance use problems (Luoma et al., 2014). Hence, self-stigma is the harmful impact that results from internalizing prejudice (Corrigan et al., 2012).

Recently, the issue of self-stigma has attracted growing attention in the field of gambling research (Horch and Hodgins, 2015; Hing et al., 2016a). Using qualitative methods, Hing et al. (2016a) showed that problem gamblers have strong feelings of self-stigma. Horch and Hodgins (2015) reported that self-stigma was associated with increased shame and reduced self-esteem in individuals with a gambling disorder. These findings are in line with studies on individuals with substance use problems that have documented high levels of self-stigma (Luoma et al., 2007; Etesam et al., 2014), and found associations between self-stigma and internalized shame and reduced self-esteem (Rodrigues et al., 2013; Luoma et al., 2014). According to Donaldson et al. (2015), people with gambling problems may share characteristics with individuals with alcohol and substance abuse associated with the experience of stigma related to their condition. Specifically, they all have high rates of comorbidities and co-stigmas considered to be adaptive disorders, where stigma often acts as a barrier to treatment and affects treatment- seeking.

One of the key attempts to account for the cognitive and emotional process of self-stigma is the Progressive Model of Self-stigma, which emphasizes its developmental and multilevel processes (Corrigan et al., 2006, 2011). In this model, self-sigma consists four successive interrelated stages: awareness (aware), agreement (agree), application (apply) and harm. Each stage is the precondition for the next one, which is trickle-down in nature. Awareness is the first stage of this cascade of stigmatizing cognitions that denotes the person's awareness of beliefs about mental illness in the culture in general. This stage actually represents the individual's perception of public stigma (Schomerus et al., 2011). This stage may lead to agreement with the stigma, where an individual with a serious mental illness believes that the stereotype is true. Subsequently, the individual concurs that these stereotypes apply to him/herself, which finally leads to the experience of harm such as loss of self-esteem. The most harmful effects of self-stigma are thought to occur in the latter stages, when a person has internalized the stigma (Corrigan et al., 2012). For example, apply and harm (the last two stages) yielded significantly greater associations with self-esteem and the negative impact of hopelessness (Corrigan et al., 2011).

In practice, two assumptions are derived from this model, which are tested in two ways (Corrigan et al., 2011, 2012; Schomerus et al., 2011): the first is the trickle-down nature of the model which requires that self-stigma scores should be the highest in aware, decline progressively thereafter, and be the lowest for the last stage of harm. The second assumption leads to the prediction that cross-step correlations should be larger for steps representing proximal (e.g., aware-agree, agree-apply) than more distant stages (aware-apply, agree-harm, or aware-harm). Several studies have tested these assumptions. Although the progressive nature of the model was supported in several (Schomerus et al., 2011; Corrigan et al., 2012), others have only lent partial support to the trickle-down nature of the process (Rüsch et al., 2006; Corrigan et al., 2011). For example, in the Corrigan et al. (2012) study, the awareness stage was significantly higher than agreement, which was higher than values of apply and harm. However, no differences were found between apply and harm. The authors concluded that the stages are split into two sets between agree and apply.

With regard to individuals with addiction disorders, Schomerus et al. (2011) tested this model on 153 individuals with a diagnosis of alcohol dependence and showed that the stepwise process of self-stigmatization in this sample was similar to the pattern observed in people with other severe mental health illnesses. However, despite these accumulating findings, to the best of our knowledge, the process of self-stigmatization formation has not been empirically explored in individuals with a gambling disorder or compared to individuals with alcohol and other substance use disorders. Given the potential long-term consequences of self-stigma among those with gambling problems (Hing et al., 2016a) it is important to better understand the way self-stigma is formed. The current study was designed to probe the applicability of the Corrigan et al. (2006, 2012) progressive model of self-stigma to individuals with gambling problems. In addition, the inclusion of gambling disorder under the umbrella of substance-related and addictive disorders, and the similarities between these disorders raises the question of whether self-stigma forms and develops in the same way in these three disorders. The multi-dimensional nature of the progressive model can be used to explore this model as a whole and determine whether it unfolds in the same way among individuals with gambling, alcohol and other substance use problems. In addition, it can reveal potential differences in self-stigma between individuals with gambling problems and individuals with alcohol and substance use problems at each stage.

Based on a literature review, two hypotheses were tested: (1) the progressive nature of the self-stigma process among the individuals with gambling problems should emerge in the same way as among individuals with alcohol or other substance use problems. Namely, in all three groups (a) the mean scores in the early stages should be higher than the mean scores at later stages; and (b) the correlations between proximal stages should be larger than the correlations between distant stages; (2) Differences should only be found between individuals with gambling problems and individuals with alcohol and other substance use problems in relation to the awareness stage of the progressive model for self-stigma; i.e., individuals with gambling problems would be less likely to be aware of the stigma than individuals with alcohol and other substance use problems.

MATERIALS AND METHODS

Sample and Procedure

This study is part of a wider longitudinal research project assessing a variety of psychological variables that predict dropping out from treatment in clinical populations of individuals with gambling, alcohol and other substance use problems (mainly heroin and cocaine). The criteria for inclusion in this study were: above age 18, residence in Israel for at least 10 years and the ability to read and write Hebrew sufficiently well to understand and fill in the questionnaires. For the purposes of this study, only individuals who met at least one item of the DSM-5 criteria related to gambling/alcohol or other substance use disorders were included in the analyses.

The sample was composed of 148 individuals who applied for treatment in out-patient rehabilitation centers for gambling, alcohol, other substances addictions in Israel. Of these, 37 individuals had gambling problems, 60 had alcohol use problems and 51 had other substance use problems. Two additional participants were excluded due to missing data. A research assistant was present at the rehabilitation treatment centers the day the subjects applied for treatment intake. After the individuals finished the intake procedure the research assistant asked them to take part in the study, and to read and sign the informed consent form. The subjects completed anonymous, confidential self-report measures, which were administered in the form of face-to-face interviews. The data were collected between 2015 and 2016. All study procedures were reviewed and approved by the Tel Aviv University Institutional Review Board and the Ministry of Welfare Review Boards. The study was conducted in accordance with the ethical standards of the American Psychological Association.

Measures

The Self-Stigma of Mental illness Short Form (SSMIS-SF) was developed by Corrigan et al. (2012) to evaluate self-stigma among people with mental-health illnesses. It contains 20 items divided into four subscales representing awareness, agreement, application, and harm to self-esteem. Each stage is represented by five items; for example, "I think the public believes most people with mental illnesses are unpredictable" represents the awareness stage, whereas the item: "I currently respect myself less because I am unpredictable" represents harm to self. Agreement with each item is expressed on a nine-point scale ranging from 1 (*strongly disagree*) to 9 (*strongly agree*). Scale scores are determined for each of the subscales separately by summing only the five items for each subscale with the highest scores, which is considered to indicate greater endorsement of self-stigma for that factor. The scale was modified for the purposes of this study to refer to gambling, alcohol and other substance use addictions by changing the term "mental illness" to gambling, alcohol or other substance use addictions as appropriate. The reliability of the subscales has been tested on different samples (Corrigan et al., 2012). Awareness ranges from $\alpha = 0.73$–0.87, agreement ($\alpha = 0.72$–0.79), application ($\alpha = 0.22$–0.74), and harm to self (0.76–0.82). In the current study, the reliabilities were $\alpha = 0.72$ for awareness, $\alpha = 0.68$ for agreement, $\alpha = 0.66$ for application, and $\alpha = 0.82$ for harm. All four self-stigma sub-scales distributed normally: awareness (skewness $= -0.385$ and kurtosis $= -0.757$); agreement (skewness $= -0.034$ and kurtosis $= -0.416$); application (skewness $= 0.592$ and kurtosis $= -0.518$), and harm (skewness $= 0.768$ and kurtosis $= -0.446$).

The severity of the addiction disorders was assessed by DSM-5 diagnostic criteria for gambling, alcohol and other substance addictions separately. On the DSM-5, gambling disorder is assessed by 9 criteria, and alcohol and other substance use disorders are assessed by 11 criteria each. The participants were asked to think about the previous 12 months and to choose one answer for each criterion. As stipulated in the DSM-5 GD guidelines, individuals with a score of 4 or above were

considered disordered gamblers and were sub-classified as having a mild (met 4–5 criteria), moderate (met 6–7 criteria) or severe (met 8–9 criteria) gambling disorder. For alcohol and other substance use disorders, individuals who scored 2 or above were considered disordered alcoholics or as having a substance disorder and were sub-classified as having mild (met 2–3 criteria), moderate (met 4–5 criteria), or severe (met 6 or more criteria) alcohol or other substance use disorders. To compare the severity levels of the three addiction problems a four-level scale (no severity/mild/moderate/severe) corresponding to the DSM-5 was used. In addition, socio-demographic information was collected for gender, level of education and age.

Statistical Analyses

Analyses were carried out with SPSS24 and AMOS 24 for Windows. First, the data were scanned to identify missing values. Only eight participants did not fill in all the items (between 1–5 missing items) on the self-stigma questionnaire. The missing values were replaced by the series mean.

A confirmatory factor analysis was used to test whether the factorial structure of the SSMIS-SF developed for mental illness was also applicable to people with gambling, alcohol and other substance use problems. After omitting item numbers 1 and 3 on the awareness subscale, items number 1 and 3 on the agreement subscale, item number 3 on the application subscale, and item number 3 on the harm scale, the stigma scale in the current sample showed good fit indices [$\chi^2(60) = 78.324$, $\chi^2/df = 1.305$, CFI = 0.978, TLI = 0.967, and RMSEA = 0.046]. Values greater than 0.90 for CFI and TLI and values ranging from 0.06 to 0.08 for RMSEA are generally deemed acceptable (Browne and Cudeck, 1993; Hu and Bentler, 1999; Kline, 2011).

Descriptive statistics were calculated to characterize the groups in terms of gender, age, educational level and addiction severity. In addition, ANOVA, Kruskal–Wallis and Fisher's exact tests were conducted to identify demographic differences between the groups. Since significant differences in gender, age, education, and addiction severity were found, these variables were controlled for in the subsequent analyses. Relationships between demographic variables and self-stigma measures were examined using MANOVA and Pearson correlations. The analyses of the progressive model assumptions followed methodology used in previous studies (Corrigan et al., 2011, 2012; Schomerus et al., 2011). The relationships between self-stigma stages were evaluated by partial correlations. The differences between stage scores, and between-group differences were evaluated by implementing repeated measures ANCOVA and one way MANCOVA.

RESULTS

Sample Description

The distributions of the demographic variables in the three groups are presented in **Table 1**. Females were a minority in all three groups, but gender proportions were group-dependent: 15% of the alcohol group, 11.8% of the other substance use group and only 2.7% of the gambling group were women. Significant age difference was found [$F(2,147) = 5.86$, $p < 0.01$, $\eta^2 = 0.074$]; namely, participants with gambling problems were younger than participants with alcohol problems (Bonferroni *post hoc* test, $p < 0.005$), whereas the age of participants with substance use problems did not differ from either group. Participants with other substance use problems were less educated than participants with alcohol or gambling problems [$\chi^2(2) = 17.59$, $p < 0.001$, $\eta^2 = 0.120$]. Significant differences were found in terms of addiction severity [$\chi^2(2) = 15.25$, $p < 0.001$, $\eta^2 = 0.104$]. The overall addiction severity was significantly lower among individuals with gambling problems than in individuals with alcohol and other substance use problems (the difference between individuals with alcohol and other substance use problems was not significant). MANOVA and Pearson correlations analyses revealed no significant relationships between demographic variables and self-stigma measures.

The Progressive Model of Self-stigma in Individuals with Gambling, Alcohol and other Substance Use Problems

The first hypothesis examined whether the progressive model of self-stigma could apply to individuals with gambling problems as it has been shown to apply to those with alcohol and substance use problems. Thus, the assumptions of the progressive model were tested for each group separately.

The first assumption of the progressive model has to do with the putative differences between stage scores. According to the model, early stage scores should be higher than later stage scores (Corrigan et al., 2011). This hypothesis was tested using a repeated measures ANCOVA, with stage (aware/agree/apply/harm) as a within-subjects independent factor, group (gambling/alcohol/substances) as a between-subjects independent factor, and gender, age, education and severity as the control variables. A significant stage*group interaction was found [$F(6,423) = 2.83$, $p = 0.01$, $\eta^2 = 0.039$]. Overall, as can be seen in **Figure 1**, the stages scores in each group were in line with the progressive model's first assumption; namely, the mean scores in the early stages were higher than the mean scores at later stages. However, Bonferroni *post hoc* tests for the interaction effect showed a slightly different pattern in each group: as can be seen in **Figure 1**, in individuals with gambling problems, the aware score was higher than the apply and harm scores ($p < 0.005$), and the apply score tended to be higher than the agree score ($p < 0.06$) and was higher than the harm score ($p = 0.05$). No significant differences were found between the aware and agree scores, or between apply and harm scores. In individuals with other substance problems, the differences between all the stages were significant ($p < 0.01$): the aware score was the highest, the agree score was lower than the aware, the apply score was lower than the agree, and the harm score was the lowest. In individuals with alcohol problems, the pattern was similar except for the absence of a significant difference between apply and harm scores. Thus overall, the first two stage scores were higher than the last two stage score in all groups, which is consistent with the assumptions the progressive model. This effect is presented in **Figure 1**.

TABLE 1 | Demographic data.

	Gambling ($N = 37$)	Alcohol ($N = 60$)	Substances ($N = 51$)	Group differences	Effect size
Gender – female *N* (%)	1 (2.7%)	9 (15%)	6 (11.8%)	FET**	$V = 0.17$
Age – *M* (*SD*)	35.00 (9.28)	43.31 (12.56)	39.60 (12.11)	$F(2,147) = 5.86$**	$\eta^2 = 0.074$
Education level mean rank	80.81	85.42	57.08	$\chi^2(2) = 17.59$***	$\eta^2 = 0.120$
Up to 8 years *N* (%)	2 (5.4)	4 (6.7)	17 (33.3)		
Up to 12 years *N* (%)	27 (73)	38 (63.3)	28 (54.9)		
Non-academic *N* (%)	3 (8.1)	7 (11.7)	6 (11.8)		
Academic *N* (%)	5 (13.5)	11 (18.3)	–		
Addiction severity – mean rank	56.35	77.73	83.86	$\chi^2(2) = 15.25$***	$\eta^2 = 0.104$
Severe *N* (%)	16 (43.2)	47 (78.3)	44 (86.3)		
Moderate *N* (%)	19 (51.4)	4 (6.7)	2 (3.9)		
Mild *N* (%)	1 (2.7)	7 (11.7)	3 (5.9)		
No severity (Met only 1 DSM item) *N* (%)	1 (2.7)	2 (3.3)	2 (3.9)		

**$p < 0.01$, ***$p < 0.001$.

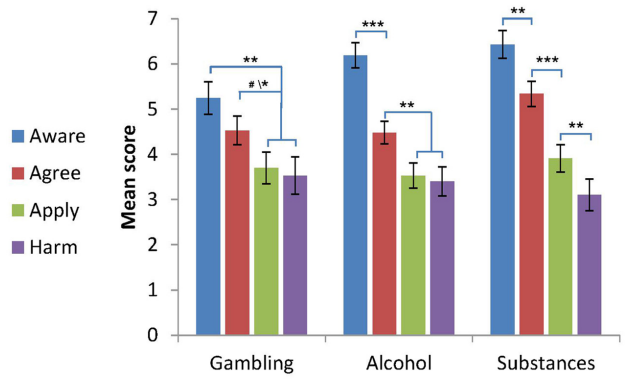

FIGURE 1 | Self-stigma scores by group (M ± SE, gender, age, education level and addiction severity were controlled for). Notations: The figure shows the progressive patterns of stage scores for each group. Gambling: aware = agree > apply = harm. Alcohol: aware > agree > apply = harm. Other substances: aware > agree > apply > harm. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, #$p < 0.06$, compared to the signed stages in each group (for the gambling group, $p < 0.06$ for the agree-apply difference, $p < 0.05$ for the agree-harm difference).

The second assumption derived from the self-stigma progressive model states that proximal stages in the hierarchy are more highly correlated than relatively distant stages. Partial correlations representing the relationships between scales (after controlling for age, gender, education and addiction severity) are presented in **Table 2**. As shown in **Table 2**, this hypothesis was partially supported. For example, proximal correlations were high for apply/harm (0.63/0.85/0.71 for the gambling, alcohol and other substances groups, respectively) compared to more distant relationships between aware and harm (0.26/0.27/0.38). In order to make sense of all these correlation coefficients, we followed the Corrigan et al. (2012) method and calculated the mean of the correlation coefficients for each proximity level in each group (after a Fisher r to z transformation). The results were as expected: in all three groups, the correlations were the highest for the proximal relationships, lower for the intervening and the lowest for the most distant (Gambling: 0.56/0.54/0.26; Alcohol: 0.68/0.39/0.27; Substances: 0.53/0.35/0.38). In fact, in individuals with other substance use problems, the second and third level correlations were close, and both were lower than first level correlations. Thus, the progressive nature of relationships between the self-stigma stages was confirmed in all three groups.

Differences between Groups in Self-stigma Stages

The second hypothesis related to potential differences between individuals with gambling problems and individuals with alcohol and other substance use problems in the self-stigma stage scores. This hypothesis was tested using a one-way MANCOVA, with four stages scores (aware/agree/apply/harm) as dependent variables, group (alcohol/substances/gambling) as an independent factor, and gender, age, education and severity as the control variables.

The multivariate effect was significant [$F(8,272) = 2.40$, $p > 0.05$, $\eta^2 = 0.066$]. Univariate analyses results, together with self-stigma scores in each group, are presented in **Table 3**. As can be seen in the table, a significant effect was found only in the awareness score [$F(2,139) = 3.71$, $p < 0.01$, $\eta^2 = 0.051$]. Bonferroni *post hoc* tests showed that the aware score among individuals with gambling problems was lower compared to individuals with other substances use problems ($p < 0.05$) and tended to be lower also compared to individuals with alcohol problems ($p < 0.06$). No between-group difference was found considering the other stages scores.

DISCUSSION

This study examined the applicability of the progressive model of self-stigma to individuals with gambling problems, and probed whether its assumptions applied in the same way as among individuals with alcohol and other substance use problems who had sought treatment at rehab centers in Israel. It also compared the three groups with respect to each of the four phases in the model. The findings partially confirmed the model's

TABLE 2 | Partial correlations between self-stigma scales by group.

	Gambling ($N = 37$)			Alcohol ($N = 60$)			Substances ($N = 51$)		
	Aware	**Agree**	**Apply**	**Aware**	**Agree**	**Apply**	**Aware**	**Agree**	**Apply**
Aware	–			–			–		
Agree	0.45**	–		0.44***	–		0.43**	–	
Apply	0.31#	0.58***	–	0.26	0.60***	–	0.36*	0.39**	–
Harm	0.26	0.71***	0.63***	0.27*	0.51***	0.85***	0.38**	0.34*	0.71***

*$p < 0.05$, **$p < 0.01$, ***$p \leq 0.001$, #$p < 0.06$ (gender, age, education level, and addiction severity were controlled for).

TABLE 3 | Self-stigma scores by group.

	Gambling ($N = 37$)		Alcohol ($N = 60$)		Substances ($N = 51$)		Group differences	Effect size
	M	***SE***	***M***	***SE***	***M***	***SE***	***F*(2,139)**	**η^2**
Aware	5.25	0.36	6.19#	0.28	6.43*	0.31	3.71, $p < 0.05$	0.051
Agree	4.53	0.32	4.48	0.25	5.34	0.28	2.61, $p > 0.05$	0.036
Apply	3.70	0.35	3.53	0.28	3.91	0.30	0.23, $p > 0.05$	0.003
Harm	3.53	0.41	3.40	0.32	3.10	0.35	0.47, $p > 0.05$	0.007

*$p < 0.05$, #$p < 0.06$, both compared to gambling group (gender, age, education level and addiction severity were controlled for).

first assumption (its trickle-down nature) and came close to confirming its second assumption (that cross scale correlation coefficients between proximal stages would be larger than distal ones), with only minor differences between the groups. With regard to the first assumption, which posits that mean scores in early stages should be higher than the following ones, in all three groups differences were found between the first two stages of the model – aware and agree versus the other two stages – apply and harm (in the gambling group this difference came close to significance). However, in subjects with an alcohol or substances use problem there was a significant difference between the aware and agree stages, and in the group of individuals with substance use problems there was also a significant difference between the apply and harm stages. The second assumption that cross-scale correlation coefficients between proximal stages would be larger than with distal ones was fully borne out in the gambling and alcohol groups, but only partly in the substance use group, where the cross-scale correlation coefficients between proximal stages were indeed larger than in the distal stages, but the correlation coefficients between the medial-distant stages were similar to the distal. In line with the second hypothesis, which compared the groups with regard to each stage individually, the analyses revealed differences for the aware stage between participants in the gambling group and those in the alcohol and other substance use groups (with the alcohol group the difference was marginally significant). Specifically, participants in the gambling groups had a lower awareness of stigma than those with alcohol and other substance use problems. There were no significant differences between the groups for the three later stages of the model; namely, agree, apply and harm.

These findings highlight the similarities and differences in self-stigma development in individuals with gambling problems as compared to those with alcohol and substance use problems. These differences and similarities held true for each of the constituent stages of this process, and with regard to the progression of self-stigma as a whole.

The differences between the gambling group and the alcohol and other substance use groups regarding the aware stage highlight this difference. The aware stage is a reflection of the public's stigma toward a given behavior, as perceived by the members of the stigmatized group (Schomerus, 2014). The findings with regards to this stage that participants with gambling problems scored lower than those with substance use and alcohol problems suggests that (in Israel, at least) these disorders can be divided into two levels of severity of public stigma. This finding echoes the results in Feldman and Crandall (2007) in the United States showing that people were less inclined to avoid the company of pathological gamblers than those with an alcohol dependence, and were most inclined to avoid people with a cocaine dependence. This finding may be accounted for by the idea that in contrast to substance addictions, in gambling – which is a behavioral addiction – the damage to physical appearance is not as prominent, is much easier to conceal (Horch and Hodgins, 2008; Donaldson et al., 2015), and hence may attract lower levels of public stigma. Therefore, public stigma with regard to any given addictive disorder may be a function of the type of addiction (substance versus behavioral).

As previously noted, the first hypothesis concerned the applicability of the progressive model to the three groups and was tested to acquire a deeper understanding of the stages of development of self-stigma in individuals with gambling, alcohol and substance use problems. The findings revealed that the principles of the model were broadly substantiated in all three groups, with only minor differences that may have been due to the size of the groups. In all three groups there was a difference between first two stages (aware and agree) and the latter stages (apply and harm). This finding is in line with results reported by Rüsch et al. (2006) and Corrigan et al. (2011), which also

found differences between the first two stages (which concern the cognitive aspect of the development of stigma) and the latter two stages, which tend to relate to the practical process of internalization and the harm caused to the individual from the stigma. The larger associations between the proximal stages, and the weaker associations with the distal stages (fully in the case of the gambling and alcohol groups, and partially in the substance group) substantiate the model for the three groups, inasmuch as the internalization of the stigma was quite similar in all the addiction disorders. Thus, the findings of this study on self-stigma tend to support the similarities found in the literature in terms of the characteristics of behavioral and substance use disorders (Hasin et al., 2013). It is important to note that a larger sample, particularly with more subjects with gambling problems, could very well have led to a more decisive corroboration of the model, including in relation to this group.

Although the link between self-stigma and socio-demographic variables was not the main purpose of this study, it is important to note that no associations were found between the self-stigma subscales and gender, age, or level of education. These findings are in line with a study conducted by Brown et al. (2015) which probed the potential associations between self-stigma and demographic and previous treatment variables among 120 individuals residing in a Midwestern U.S. state substance use facility. The authors concluded that demographic variables, including gender, do not seem to be particularly relevant with regard to self-stigma. However, given the notion that women with gambling problems bear a dual stigma as a result of having both gambling problems and because of their failure to meet certain social gender expectations (Lesieur and Blume, 1991; Brown and Coventry, 1997) the findings – both in this study and in previous work – are surprising. More studies should be conducted on women and men separately using qualitative and quantitative methods.

The current study found no associations between addiction severity and the self-stigma sub-scales. Given previous findings which have found a relationship between substance use diagnosis and the self-devaluation and fear of enacted stigma scales (Brown et al., 2015), and a link between the apply and harm subscales of the SSMIS-SF and severity of drinking problems in 153 patients hospitalized for alcohol detoxification (Schomerus et al., 2011) more studies should be conducted to clarify this issue.

Understanding self-stigma and its development is crucial to reducing its adverse effects on the individual, at all stages of treatment – seeking treatment, treatment itself and recovery. The findings show that despite the differences between the groups in the first stage of the model, there was no difference between the groups for the agree, apply and harm stages, and the groups fell broadly in line with the model's assumptions in general, as was shown by the divisions between the early and later stages. Hence, these differences and similarities between groups should be reflected in prevention programs as well. In terms of the process of self-stigma development as a whole, the same practices should be implemented for all individuals who suffer from self-stigma stemming from their addictive disorders (whether behavioral or substance related). However, the differences between the groups in the aware stage emphasize the need to develop tailored interventions programs that take different public attitudes into account.

This study also has a number of limitations. Most studies have argued that high stigma is a major deterrent to seeking treatment for people with gambling problems (Rockloff and Schofield, 2004; Gainsbury et al., 2014; Hing et al., 2016a), as well as for those with alcohol and other substance problems. Since the participants in this study all actively sought treatment, it is possible that they experienced lower levels of self-stigma than individuals who avoid doing so. In addition, this study was based on self-reports with no cross-referencing to other sources, and on a relatively small sample. Further studies should be conducted with larger numbers of participants – both those who have sought treatment and those who have not. Despite these limitations, this study contributes to the body of knowledge on the stages in which self-stigma develops among individuals with gambling problems, and is the first study to compare the assumptions of the progressive model on a clinical sample of individuals with alcohol and other substance use problems to individuals with gambling problems. The findings of this study should thus pave the way for further studies in this field.

AUTHOR CONTRIBUTIONS

BG-F wrote the manuscript and was involved in the statistical analyses. TR was involved in solidifying the main research questions and was responsible for some aspects of the methodological part of the manuscript and for the data collection. The authors discussed the research findings and their implications together. Overall, BG-F and TR contributed significantly to this study.

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Food Addiction in Gambling Disorder: Frequency and Clinical Outcomes

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Background: The food addiction (FA) model is receiving increasing interest from the scientific community. Available empirical evidence suggests that this condition may play an important role in the development and course of physical and mental health conditions such as obesity, eating disorders, and other addictive behaviors. However, no epidemiological data exist on the comorbidity of FA and gambling disorder (GD), or on the phenotype for the co-occurrence of GD+FA.

Objectives: To determine the frequency of the comorbid condition GD+FA, to assess whether this comorbidity features a unique clinical profile compared to GD without FA, and to generate predictive models for the presence of FA in a GD sample.

Method: Data correspond to $N = 458$ treatment-seeking patients who met criteria for GD in a hospital unit specialized in behavioral addictions.

Results: Point prevalence for FA diagnosis was 9.2%. A higher ratio of FA was found in women (30.5%) compared to men (6.0%). Lower FA prevalence was associated with older age. Patients with high FA scores were characterized by worse psychological state, and the risk of a FA diagnosis was increased in patients with high scores in the personality traits harm avoidance and self-transcendence, and low scores in cooperativeness ($R^2 = 0.18$).

Conclusion: The co-occurrence of FA in treatment-seeking GD patients is related to poorer emotional and psychological states. GD treatment interventions and related behavioral addictions should consider potential associations with problematic eating behavior and aim to include techniques that aid patients in better managing this behavior.

Keywords: food addiction, gambling disorder, comorbidity, sex, personality

INTRODUCTION

Food Addiction

The applicability of the criteria for substance dependence disorders in the Fourth Edition of the Diagnostic and Statistical Manual of Mental Disorders (Álvarez-Moya et al., 2010) to behavioral addictions, including overeating, was greatly disputed (Moreno and Tandon, 2011). The Fifth Edition of the DSM (APA, 2013) chose to merge the diagnostic criteria for abuse and dependence into a single category of "substance-related and addictive disorders," which listed only gambling disorder as a behavioral addiction, arguing that additional research-based validation was required in order to determine the transferability of the new DSM-5 criteria to other addictive behaviors (Pai et al., 2014; Potenza, 2014). Scientific research on food addiction (FA) is still in its nascent stages and currently, no consensus exists regarding a precise operational definition of FA, although this term is commonly used in areas such as obesity, eating disorders, and behavioral addictions. Systematic clinical and translational studies are scarce in the literature and evidence for a substance-related addiction to the specific nutrients found in foods is poor (Ziauddeen and Fletcher, 2013; Meule and Gearhardt, 2014; Long et al., 2015). Some authors have consequently posited that the term "eating addiction" may more accurately describe the behavioral components of addictive-like eating behavior (Avena et al., 2011; Hebebranda et al., 2014) than FA.

As the term *behavioral addiction* implies a continued, persistent, excessive, impulsive, and uncontrollable involvement in an activity despite the negative consequences, definitions for FA should accordingly include the combination of both, "substance-related" and "behavioral addiction" concepts. Recent research supports the notion that hyper-palatable foods may have addictive potential in some individuals because the increased potency of certain nutrients (Meule, 2015) and palliative properties may provide a form of self-medication (Fortuna, 2012) or natural reward (Hoch et al., 2015). Comprehensive reviews on studies in human and animal samples have also recognized that problematic eating behavior (including FA) constitutes a multifactorial condition that can involve a combination of metabolic, genetic, environmental, psychological, and behavioral factors, and that eating can be regulated by factors unrelated to metabolic control, such as stress and emotions (Macht, 2008; Hildebrandt and Greif, 2013; Di Segni et al., 2014).

Other results obtained in animal and human research within the context of the effects of food intake on brain reward systems have revealed that palatable foods can mimic the neurophysiological and behavioral effects of addictive drugs (Albayrak et al., 2012; de Jong et al., 2012; García-García et al., 2014; Cenci et al., 2015; Karlsson et al., 2015; Ziauddeen et al., 2015). Alterations in neurotransmission as a consequence of the perpetual intake of highly palatable foods have also been reported in both animal models and individuals with excess weight (Baik, 2013; Mietlicki-Baase et al., 2013; D'Souza, 2015). Furthermore, the anorexigenic effects of leptin also seem attenuated in FA, potentially leading to weakened food-reward (Bowen et al., 2014). Finally, some reviews centered on the neurobiological basis of FA and binge eating suggest that compulsive-addictive food intake could be considered from an evolutionary perspective, underscoring the importance of motivational systems involved in adaptive patterns of food intake (Salamone and Correa, 2013; Davis, 2014). Other studies propose that FA may simply be a more acute form of binge eating disorder (Davis, 2013) or a valid phenotype of obesity (Davis et al., 2011).

A genetic overlap between non-substance- and substance-related addictions has been implied by formal genetic studies (Slutske et al., 2000, 2013; Eisen et al., 2001; Blanco et al., 2012; Slutske and Richmond-Rakerd, 2014). The first genome-wide association study (GWAS) for food addiction (determined by the modified Yale Food Addiction Scale; mYFAS) in 9,314 women of European descent revealed two loci with genome wide significance ($P < 2.5 \times 10^{-8}$). Additionally, the GWAS data implied an enrichment for gene members of the MAPK signaling pathway ($P = 0.02$). However, candidate SNPs or genes for drug addiction were not associated with food addiction (Cornelis et al., 2016). Recently the first GWAS for pathological gambling was performed on 445 cases and 986 controls (Lang et al., 2016). Although, genome-wide significant variants were not detected, some pathway analyses were significant. Additionally, the analysis of a genetic overlap between pathological gambling and alcohol dependence revealed, by polygenic risk score analysis of the alcohol dependence dataset, a one-sided nominally significant *P*-value in individuals with pathological gambling. A combined analysis of genetic data pertaining to food addiction and gambling disorder has not yet been published.

Prevalence estimates for FA in developed countries vary greatly, depending on the assessment tools employed and the type of sample studied (e.g., general population, obese, student, or clinical samples). A systematic review that meta-analyzed 25 studies ($n = 196{,}211$) obtained a weighted mean prevalence of FA equal to 19.9% (Pursey et al., 2014). Studies using obese samples have obtained point prevalence rates between 34% (Ceccarini et al., 2015) and 40% (Meule et al., 2014); for university student samples point-prevalence is around 11% (Obregón et al., 2015). Epidemiological research further shows, that FA is more prevalent in women (Fattore et al., 2014), middle-aged and older individuals (Bowen et al., 2014; Flint et al., 2014), overweight/obese patients (Meule, 2012; Pedram et al., 2013; Lee et al., 2014), and in people of Black or Hispanic ethnicity or low socioeconomic status (Berenson et al., 2015).

Gambling Disorder

Gambling disorder (GD) is the only non-substance behavioral addiction in the diagnostic category "substance-related and addictive disorders" in the DSM-5 (APA, 2013). It constitutes a mental health disorder characterized by persistent and recurrent problematic gambling behavior leading to clinically significant impairment or distress. Numerous studies have reported empirical evidence on the frequency of GD in different samples/populations, its main risk factors, clinical phenotype, and treatment outcomes (Johansson et al., 2009; Cowlishaw et al., 2012; Bartley and Bloch, 2013; Gowing et al., 2015; Hing et al., 2015; Moragas et al., 2015).

Systematic reviews confirm commonalties between GD and other behavioral addictions (including FA) in terms of

neural and psychological underpinnings (Cenci et al., 2015; Engel and Cáceda, 2015; Yau and Potenza, 2015; Grant et al., 2016), particularly with regard to (a) cognitive dysfunction manifested in the form of impulsivity and compulsivity; (b) structural and functional abnormalities of networks involved in reward processing and top-down control; (c) alterations in neurochemical-neuroendocrine systems implicated in pathophysiology; (d) elevated personality traits scores in negative urgency, disinhibition and novelty seeking; and (e) familial diathesis.

Epidemiological research outlines that worldwide prevalence for GD in adult populations has significantly increased in recent years. A recently published meta-analysis reported estimated prevalence of lifetime GD ranging from 0.01 to 10.6%, across studies, with higher point values among younger age groups and males, and higher risk-vulnerabilities for groups with fixed incomes and limited prospects of future earnings (Subramaniam et al., 2015).

Regarding comorbidity between eating disorders and gambling disorder, a study with a sample of 1,681 consecutive treatment-seeking eating disorder patients (1,576 females and 105 males), found that the lifetime prevalence of GD was 1.49%, similar to rates found in the general population, which stands at 1.5% (Jimenez-Murcia et al., 2013; Gowing et al., 2015). However, when considering ED subtype, GD was highly associated with binge eating disorder (5.7%). On the other hand, GD was also found to be more frequent in men (16%) than in women (1.26%), as seen from studies conducted both in the general population (Bonnaire et al., 2016) and in clinical samples (Erbas and Buchner, 2012; Jiménez-Murcia et al., 2014).

Another study, in this case, carried out with psychiatric inpatients, GD prevalence was found to be 9% and only one patient had an eating disorder associated with GD (Aragay et al., 2012). Despite the low comorbidity between the two conditions, results radically differ when the gender is considered. The fact that ED are more common in women has resulted in an overrepresentation of this gender in the literature and many studies have opted to exclude men from their study samples for the sake of homogeneity. Therefore, awareness of comorbidity between these two conditions is low.

However, GD and FA phenotypes share many common features. Firstly, both psychiatric conditions could be considered as forming part of the impulse control disorder spectrum, with the most evident shared attribute being the impulsive/compulsive nature of the addictive behavior (Leeman and Potenza, 2012; Grant and Chamberlain, 2014; Di Nicola et al., 2015; Konkolÿ Thege et al., 2015). Other shared characteristics are the early onset of these problematic/excessive behaviors (Balogh et al., 2013), high exposure to adverse life events (Lee et al., 2012), personality traits characterized by high scores in impulsivity, high levels of emotional-psychological distress (Karim and Chaudhri, 2012), and difficulties in emotion regulation (Williams et al., 2012; Pivarunas and Conner, 2015).

Aims

Despite the similarities between GD and FA, to our knowledge no empirical study has estimated the co-occurrence of FA in GD samples, or the potential effects of the presence of FA in treatment-seeking GD samples. The objectives of this study were therefore: (a) to screen for the epidemiological occurrence of FA in a clinical sample of treatment-seeking patients who meet DSM-5 criteria for GD; (b) to assess whether GD patients with FA exhibit more severe gambling disorder severity, more maladaptive personality profiles, and greater general psychopathology, when compared to GD patients without FA; (c) to obtain predictive models of FA symptoms in patients with GD; and (d) to conduct a path analysis to explore the underlying mechanisms of GD and FA severity while considering patients' sex, age, and personality profile.

MATERIALS AND METHODS

Participants

Participants considered for the study were all patients referred to the Pathological Gambling Unit in the Psychiatry Department at Bellvitge University Hospital (Barcelona, Spain), for treatment of behavioral-addiction problems between September 2013 and December 2015 that met *DSM*-IV criteria for GD (called pathological gambling before the publication of the DSM-5) ($N = 458$). Bellvitge University Hospital is a public hospital certified as a tertiary care center for the treatment of addictive behaviors that oversees the treatment of highly complex cases. The catchment area of the hospital includes over two million people in Barcelona metropolitan area. All individuals who arrived to the specialized unit were assessed by expert clinical psychologists and psychiatrists with more than 15 years of clinical experience. Descriptive information for the total sample is included in **Table 1**. Most participants were male (87.1%), born in Spain (98.9%), with a primary (57.2%) or secondary school (35.8%) level of education, about half of the patients were married (49.1%). Mean age for the whole sample was 42.7 years ($SD = 14.1$), the mean age of onset of GD was 37.8 years ($SD = 14.9$) and the mean duration of problem gambling was 5.4 years ($SD = 6.9$).

Instruments

Symptom Checklist-Revised (SCL-90-R; Derogatis, 1990)

The SCL-90 is a 90-item self-report questionnaire measured on an ordinal 3-point scale to evaluate a broad range of psychological problems and psychopathological symptoms. It is structured in nine primary symptom-dimensions: somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. Three global indices are also available: global severity index (GSI, a measure of overall psychological distress), positive symptom distress index (PSDI, a measure of the symptoms' intensity), and positive symptom total (PST, which reflects the total of self-reported symptoms). The Spanish adapted version was used in this study (Derogatis, 2002). Cronbach's alpha (α) in the sample of this study ranged from good to excellent (see α-values in **Table 3**).

TABLE 1 | Descriptives for the sample.

		Total; $n = 458$		Only-GD; $n = 416$		GD+FA; $n = 42$				
		n	%	*n*	%	*n*	%	χ^2	*df*	*p*
Sex	Female	59	12.9	41	9.9	18	42.9	37.02	1	**<0.001***
	Male	399	87.1	375	90.1	24	57.1			
Origin	Spain	453	98.9	411	98.8	42	100	0.51	1	0.475
	Immigrant	5	1.1	5	1.2	0	0			
Education level	Primary	262	57.2	237	57.0	25	59.5	2.32	2	0.313
	Secondary	164	35.8	152	36.5	12	28.6			
	University	32	7.0	27	6.5	5	11.9			
Civil status	Single	175	38.2	154	37.0	21	50.0	2.75	2	0.253
	Married—in couple	225	49.1	208	50.0	17	40.5			
	Divorced—separated	58	12.7	54	13.0	4	9.5			
Employment status	Employed	231	51.0	206	50.1	25	59.5	1.35	1	0.246
Tobacco use	Yes	247	53.9	231	55.5	16	38.1	4.67	1	**0.031***
Alcohol abuse	Yes	73	16.0	69	16.6	4	9.5	1.43	1	0.231
Other drug abuse	Yes	56	12.4	51	12.4	5	12.2	0.01	1	0.968
		Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***	**T**	***df***	***p***
	Age (years)	42.67	14.06	43.12	14.00	38.17	14.05	2.18	456	**0.029***
	Onset of GD (years)	37.81	14.88	38.21	14.92	33.90	14.02	1.79	456	0.074
	Duration of GD (years)	5.35	6.94	5.41	7.04	4.77	5.96	0.57	456	0.568

*SD, standard deviation; GD, gambling disorder; FA, food addiction; *Bold: significant result (0.05 level).*

Temperament and Character Inventory-Revised (TCI-R; Cloninger, 1999)

Self-report to evaluate personality traits on 240-items measured on a 5-point Likert-type scale. It is structured in seven primary personality dimensions: four temperamental factors (novelty seeking, harm avoidance, reward dependence, and persistence) and three character dimensions (self-directedness, cooperativeness, and self-transcendence). The Spanish revised version used in this study (Gutiérrez-Zotes et al., 2004) showed adequate internal consistency (Cronbach's alpha α mean value of 0.87). Cronbach's alpha in the sample of this work was in the range moderate to excellent (see **Table 3**).

Diagnostic Questionnaire for Pathological Gambling According to DSM Criteria (Stinchfield, 2003)

This 19-item questionnaire allows assessing the DSM-IV (Álvarez-Moya et al., 2010) and DSM-5 (APA, 2013) diagnostic criteria for GD. Convergent validity with the SOGS scores in the original version was very good ($r = 0.77$ for representative samples and $r = 0.75$ for gambling treatment groups; (Stinchfield, 2003). Internal consistency of the Spanish adaptation used in this study was $\alpha = 0.81$ for the general population and $\alpha = 0.77$ for gambling treatment samples (Jiménez-Murcia et al., 2009b). In this study, the total number of DSM-5 criteria for GD was analyzed. α-value in the sample of this study was adequate (see **Table 3**).

South Oaks Gambling Screen (SOGS; Lesieur and Blume, 1987)

Self-report 20-item screening questionnaire that discriminates between probable pathological, problem and non-problem gamblers. The Spanish validation used in this work showed excellent internal consistency ($\alpha = 0.94$) and test-retest reliability ($r = 0.98$; Echeburúa et al., 1994). α-value in the study sample was adequate (see **Table 3**).

Yale Food Addiction Scale (YFAS; Gearhardt et al., 2009)

This is a 25-item self-report questionnaire for measuring FA during the previous 12 months according to the seven symptoms of substance-dependence listed in the DSM-IV (APA, 2000). This instrument has been modified for eating behaviors and obtains two scores: (a) a quantitative dimensional score obtained as the sum of DSM-IV addictive symptoms (raw scores ranging from 0 to 7); and (b) a screening of FA diagnosis. A raw score higher than 3 combined with clinically significant impairment/distress is considered as meeting the criteria for FA diagnosis. The validation of the English version showed adequate internal consistency, good convergent, and incremental validity in predicting binge eating (Gearhardt et al., 2009). The Spanish version of the scale has also reported good psychometrical properties in Spanish-speaking samples with eating disorders (Granero et al., 2014)

and internal consistency in this study sample was excellent ($\alpha = 0.93$).

Additional Data

Demographic, clinical, drug/alcohol, tobacco, and social/family variables were taken using a semi-structured face-to-face clinical interview (Jiménez-Murcia et al., 2006).

Procedure

The present study was carried out in accordance with the latest version of the Declaration of Helsinki. The University Hospital of Bellvitge Ethics Committee of Clinical Research approved the study, and signed informed consent was obtained from all participants. Experienced psychologists and psychiatrists conducted two face-to-face clinical interviews, before and after the evaluation, in order to obtain clinical information that allows for an accurate diagnosis and that lets the clinicians choose the most appropriate treatment.

Statistical Analysis

Statistical analysis was carried out with Stata13.1 for Windows (StataCorp., 2013). Firstly, the initial sample of $N = 458$ participants was classified in two groups according to their FA diagnosis: GD without meeting FA diagnostic criteria on the YFAS (<3 criteria fulfilled; named only-GD in this work; $n = 416$) and GD with FA diagnosis on the YFAS (≥3 criteria fulfilled and clinically significant impairment/distress; named GD+FA in this work; $n = 44$). Analysis of Variance (ANOVA) procedures, adjusted for the covariates patients' sex and age, were used to compare the means in the quantitative clinical measures (gambling related variables, SOGS total score, SCL-90R, and TCI-R scale scores) between the only-GD and GD+FA groups. Bonferroni-Simes correction controlled the inflation in Type-I error due to multiple statistical comparisons (Simes, 1986). Effect sizes for the proportion and mean comparisons was estimated through Cohen's-*d* coefficient, considering $|d| > 0.50$ as a moderate effect size and $|d| > 0.80$ as a large effect size.

Secondly, partial correlations (also adjusted for the covariates sex and age) estimated the association between FA severity (dimensional YFAS raw scores) and clinical measures related to gambling, general psychopathology, and personality. $|r| > 0.30$ was considered good effect size.

Thirdly, step-wise regressions were used to estimate the best predictive models for the FA measure. Linear regression was used for the criterion YFAS raw total score, and adjusted-R^2 measured the global predictive capacity of the final model. Logistic regression was used for the criterion of FA diagnosis on the YFAS scale (1 = present vs. 0 = absent). For the logistic model, Hosmer–Lemeshow test valued the goodness-of-fit of the final regression, Nagelkerke's R^2 measured global predictive capacity and the area under the ROC curve (AUC) valued discriminative capacity. Modeling was done in two steps-blocks: the first block included and fixed the variables patients' sex and age, and the second block added and automatically selected the best predictors between the personality traits scores (TCI-R scales).

Finally, Structural Equation Modeling (SEM) was conducted to test the potential underlying mechanism through pathway analysis between patients' sex and age, personality traits, FA severity, and gambling related measures. The Maximum Likelihood method of parameter estimation was used and goodness-of-fit was evaluated using the usual statistics: the chi-square test (χ^2), the Root Mean Square Error of Approximation (RMSEA), the Bentler's comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Standardized Root Mean Square Residual (SRMR). Adequate model fit was considered for non-significant χ^2 test, RMSEA < 0.08, TLI > 0.9, CFI > 0.9, and SRMR < 0.1. The global predictive capacity of the model was measured with the Coefficient of Determination (CD).

RESULTS

Epidemiology of GD+FA Comorbidity

Table 2 contains the epidemiological indexes for the occurrence of FA measured through the YFAS questionnaire: the scores for the seven criteria for FA, the prevalence for the presence of impairment/distress due to FA, the prevalence of FA diagnosis, and the mean for FA severity (dimensional YFAS raw total score). The frequency distributions of **Table 2** are tabulated for the total sample and for the subsample of patients who were given a FA diagnosis.

Considering the whole GD sample, the prevalence of patients with FA diagnosis was 9.17% (95%CI: 6.86–12.2%). Stratifying for the patients' sex, this prevalence was significantly higher for women (30.5%; 95%CI: 20.3–43.1%) than for men (6.02%; 95%CI: 4.08–8.79%) ($\chi^2 = 19.1$, $df = 1$, $p < 0.001$). Mean FA severity scores, measured through the dimensional YFAS raw total scores, also differed between genders (being higher for women than for men: 3.3 vs. 1.8; $F = 54.4$ $df = 1$–457, $p < 0.001$). Comparing each FA criterion and the presence of impairment/distress due to FA between genders, all items obtained higher prevalence for women than for men.

The comparison of each FA criterion between the two groups of the study (with and without a FA diagnosis) achieved significant results for all criteria except for "persistent desire." Cohen's-*d* coefficients estimated high effect sizes for all criteria with significant results. These coefficients, which can also be interpreted as a measure of the item's relevance to differentiate between the groups, suggest that the most important discriminative criterion is the presence of impairment-distress, followed by *3-much time spent to obtain food*, *7-withdrawal*, *6-tolerance*, *1-food consumed for long period/larger amount than intended*, *4-social impairment,* and *5-use despite negative consequences*. Persistent desire was the least relevant criterion to differentiate between groups.

Table S1 contains the frequency distribution of the FA measures in the sub-sample GD+FA ($n = 42$), and the comparison between women and men. Point estimations showed that, as a whole, women had higher FA prevalence compared to men, but the two only criteria with significant differences between genders were *1- food consumed for long period/larger amount than intended* and *7-withdrawal*.

TABLE 2 | Distribution of the food addiction measures (YFAS).

	Total; $n = 458$		Women; $n = 59$		Men; $n = 399$					Only-GD $n = 416$		GD+FA $n = 42$				
	n	%	*n*	%	*n*	%	$\chi^2_{df=1}$	*p*	|*d*|	*n*	%	*n*	%	$\chi^2_{df=1}$	*p*	|*d*|
1. Long period	56	12.2	23	39.0	33	8.3	45.18	**<0.001***	**0.78†**	33	7.9	23	54.8	77.95	**<0.001***	**1.17†**
2. Persistent desire	419	91.5	58	98.3	361	90.5	4.04	**0.044***	0.35	378	90.9	41	97.6	2.23	0.135	0.29
3. Much time	88	19.2	23	39.0	65	16.3	17.05	**<0.001***	**0.52†**	53	12.7	35	83.3	122.5	**<0.001***	**2.00†**
4. Social impairment	54	11.8	17	28.8	37	9.3	18.87	**<0.001***	**0.51†**	33	7.9	21	50.0	64.91	**<0.001***	**1.05†**
5. Use despite cons.	144	31.4	27	45.8	117	29.3	6.44	**0.011***	0.34	117	28.1	27	64.3	23.14	**<0.001***	**0.78†**
6. Tolerance	107	23.4	25	42.4	82	20.6	13.67	**<0.001***	**0.50†**	77	18.5	30	71.4	59.67	**<0.001***	**1.26†**
7. Withdrawal	52	11.4	20	33.9	32	8.0	34.20	**<0.001***	**0.67†**	26	6.3	26	61.9	117.4	**<0.001***	**1.45†**
Impairment-distress	51	11.1	19	32.2	32	8.0	30.38	**<0.001***	**0.63†**	9	2.2	42	100.0	369.0	**<0.001***	**9.51†**
FA: positive screen	42	9.2	18	30.5	24	6.0	37.02	**<0.001***	**0.67†**	0	0	42	100	—	—	—
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***	$F_{df=1;456}$	*p*	|*d*|	**Mean**	***SD***	**Mean**	***SD***	$F_{df=1;456}$	*P*	|*d*|
FA-raw-total score	2.01	1.49	3.27	2.19	1.82	1.25	54.44	**<0.001***	**0.81†**	1.72	1.17	4.83	1.38	261.6	**<0.001***	**2.44†**

FA, food addiction; SD, standard deviation; |d|, Cohens'-d measuring effect size of differences.
**Bold: significant result (0.05 level).*
† Bold: moderate (|d| > 0.50) to high (|d| > 0.80) effect size.

Comparison between the Only-GD and GD+FA Diagnostic Subtypes

Table 1 shows the comparison for the main socio demographic variables of the study. The percentage of women in the GD+FA group was statistically higher than for the GD-only condition (42.9 vs. 9.9%, $p < 0.001$). Statistical differences between diagnostic subtypes also emerged for tobacco use (higher prevalence in the only-GD group; 55.5 vs. 38.1%, $p = 0.031$) and age (higher mean for only-GD patients; 43.1 vs. 38.2 in the GD+FA group, $p = 0.029$). No differences emerged between the two groups for the age of onset and duration of gambling problems, the individuals' origin (Spanish nationals vs. those of non-community origin), education level, civil status, employment status, and drug use (alcohol and other substances).

The first part of **Table 3** shows the results of the ANOVA adjusted for the patients' sex and age comparing the main clinical variables of the study between only-GD and GD+FA patients. The presence of high FA scores was statistically and clinically related to worse psychopathological states (higher means in all the SCL-90R scales), higher mean scores in the personality traits harm avoidance and self-transcendence, and lower means on the cooperativeness and self-directedness scales.

The second part of **Table 3** contains partial correlations (also adjusted for patients' sex and age) between the dimensional FA-raw-total score and clinical measures. High FA scores were related to worse psychopathological state (higher SCL-90-R scores). Regarding personality traits, FA-raw-total scores were significantly and positively associated with harm avoidance and self-transcendence and negatively correlated with self-directedness and cooperativeness.

Predictive Model for FA Diagnosis and Severity

The first model shown in **Table 4** corresponds to the final logistic regression measuring the contribution of sex and age to the presence of a FA diagnosis on the YFAS (1 = present vs. 0 = absent), and the main personality predictors of this criterion. Results indicate that risk of a FA diagnosis is higher for women; patients of a younger age and those with higher scores in the personality traits harm avoidance and self-transcendence. The predictive capacity of the final model was good (Nagelkerke's-$R^2 = 0.22$) as well as its discriminative capacity (AUC = 0.86).

The second model shown in **Table 4** corresponds to the final multiple linear regression measuring the contribution of sex and age on the dimensional YFAS-raw-total score (measuring FA severity), and the main personality predictors of this criterion. This model indicated that FA severity was higher for women, patients of a younger age and higher scores in the personality traits harm avoidance and self-transcendence, and lower scores in cooperativeness. The predictive capacity of the final model was good (Nagelkerke's-$R^2 = 0.18$).

SEM Exploring the Interrelationships between Sex, Age, Personality, FA, and Gambling

Figure 1 contains the pathway analysis with the main variables of the study explaining FA and GD severity. Results confirm the direct associations obtained in the previous regression models: FA severity is explained by being female, younger age, higher scores in the personality traits harm avoidance and self-transcendence, and lower scores in cooperativeness. And in addition to these direct associations, two relevant mediation effects also emerged: (a) FA severity was a mediating factor in the relationships between patients' sex, age, and the three personality traits on the one hand, and global psychopathological state on the other hand (SCL-90-R GSI score); (b) gambling severity (SOGS-total score) was a mediator between the personality traits cooperativeness and harm avoidance and psychopathological state (SCL-90-R GSI). Other mediation effects were found for the personality traits scores: harm avoidance mediated the

TABLE 3 | Association between clinical measures for patients with FA measures.

		Only-GD; $n = 416$		GD+FA; $n = 42$		ANOVA adjusted by sex-age				FA-raw-total score[a]	
		Mean	*SD*	Mean	*SD*	MD	$F_{(1, 454)}$	*p*	|*d*|	*r*	*p*
Number addictive games		1.04	0.33	1.05	0.31	0.01	0.03	0.864	0.03	0.045	0.340
Maximum bets (euros)		2,301	16,629	1,005	4,095	12,95.2	0.23	0.633	0.11	0.088	0.059
Mean bets (euros)		181.08	940.32	56.59	127.87	124.49	0.66	0.417	0.19	−0.027	0.569
Cumulate debts (euros)		12,448	50,753	7,542	29,054	4906.1	0.34	0.558	0.12	−0.009	0.845
DSM-5: total criteria	$\alpha = 0.74$	6.88	2.15	7.39	2.21	0.52	1.99	0.159	0.24	0.086	0.065
SOGS: total score	$\alpha = 0.73$	10.00	3.15	10.43	3.36	0.43	0.64	0.425	0.13	0.034	0.463
SCL-90R: Somatization	$\alpha = 0.90$	0.94	0.81	1.70	1.06	0.77	30.43	**<0.001***	**0.81†**	0.263	**<0.001***
SCL-90R: Obsessive/comp.	$\alpha = 0.87$	1.13	0.83	1.84	1.06	0.70	24.53	**<0.001***	**0.74†**	0.220	**<0.001***
SCL-90R: Sensitivity	$\alpha = 0.87$	1.05	0.85	1.72	1.08	0.67	21.06	**<0.001***	**0.68†**	0.210	**<0.001***
SCL-90R: Depressive	$\alpha = 0.91$	1.55	0.95	2.18	1.08	0.64	15.89	**<0.001***	**0.63†**	0.185	**<0.001***
SCL-90R: Anxiety	$\alpha = 0.89$	1.02	0.82	1.77	1.14	0.76	28.16	**<0.001***	**0.76†**	0.255	**<0.001***
SCL-90R: Hostility	$\alpha = 0.83$	0.93	0.83	1.48	1.09	0.55	14.56	**<0.001***	**0.57†**	0.157	**0.001***
SCL-90R: Phobic anxiety	$\alpha = 0.83$	0.46	0.66	1.10	1.19	0.64	27.24	**<0.001***	**0.66†**	0.240	**<0.001***
SCL-90R: Paranoid	$\alpha = 0.78$	0.96	0.78	1.56	1.06	0.60	19.63	**<0.001***	**0.65†**	0.214	**<0.001***
SCL-90R: Psychotic	$\alpha = 0.84$	0.90	0.77	1.53	0.89	0.63	22.56	**<0.001***	**0.75†**	0.236	**<0.001***
SCL-90R: GSI score	$\alpha = 0.98$	1.07	0.71	1.74	0.94	0.68	30.13	**<0.001***	**0.81†**	0.258	**<0.001***
SCL-90R: PST score	$\alpha = 0.98$	46.96	21.35	61.81	19.48	14.85	17.29	**<0.001***	**0.73†**	0.188	**<0.001***
SCL-90R: PSDI score	$\alpha = 0.98$	1.87	0.59	2.34	0.71	0.47	21.96	**<0.001***	**0.72†**	0.261	**<0.001***
TCI-R: Novelty seeking	$\alpha = 0.73$	108.89	14.68	109.99	13.43	1.10	0.20	0.762	0.08	0.088	0.060
TCI-R: Harm avoidance	$\alpha = 0.83$	101.03	17.45	108.58	16.83	7.55	6.51	**0.026***	**0.50†**	0.106	**0.023***
TCI-R: Reward dependence	$\alpha = 0.77$	99.37	14.82	99.96	12.93	0.59	0.06	0.812	0.04	−0.002	0.958
TCI-R: Persistence	$\alpha = 0.88$	106.02	22.22	108.96	18.15	2.94	0.62	0.604	0.14	0.016	0.732
TCI-R: Self-directedness	$\alpha = 0.87$	130.68	21.89	117.02	21.24	13.66	13.55	**0.002***	**0.63†**	−0.216	**<0.001***
TCI-R: Cooperativeness	$\alpha = 0.81$	131.97	16.69	125.17	19.35	6.81	5.56	**0.003***	0.38	−0.156	**0.001***
TCI-R: Self-Transcendence	$\alpha = 0.84$	62.38	14.91	70.31	15.10	7.93	10.38	**0.005***	**0.53†**	0.182	**<0.001***

[a] *Partial correlation adjusted by sex and age.*

GD, gambling disorder; FA, food addiction; SOGS, South Oaks Gambling Screen; SCL-90R, Symptom Checklist-Revised; TCI-R, Temperament and Character Inventory—Revised.
**Bold: significant comparison (0.05 level). † Bold: moderate (|d| > 0.50) to high (|d| > 0.80) effect size. p-values include Bonferroni–Simes correction for multiple statistical tests.*

TABLE 4 | Predictive models for the outcomes FA diagnosis and FA total score.

Criterion: FA diagnosis	**B**	**SE**	**Wald(1)**	***p***	**OR**	**95%CI (OR)**	
Sex (female)	1.799	0.378	22.625	<0.001	6.04	2.88	12.68
Age (years-old)	−0.035	0.014	6.590	0.010	0.97	0.94	0.99
TCI-R: Harm avoidance	0.028	0.010	7.325	0.007	1.03	1.01	1.05
TCI-R: Self-Transcendence	0.033	0.011	8.912	0.003	1.03	1.01	1.06
Constant	−6.436	1.477	18.975	<0.001	0.01		
Fitting: Hosmer-Lemeshow = 0.114; Nagelkerke's-$R^2 = 0.22$; AUC = 0.86							
Criterion: FA total score	**B**	**SE**	**Beta**	***t***	***p***	**95%CI (B)**	
Sex (female)	1.335	0.193	0.301	6.929	<0.001	0.956	1.714
Age (years-old)	−0.015	0.005	−0.145	−3.302	0.001	−0.024	−0.006
TCI-R: Harm avoidance	0.007	0.004	0.087	2.010	0.045	0	0.015
TCI-R: Cooperativeness	−0.011	0.004	−0.130	−3.004	0.003	−0.019	−0.004
TCI-R: Self-Transcendence	0.018	0.004	0.178	4.027	<0.001	0.009	0.026
Constant	2.121	0.736		2.882	0.004	0.675	3.567
Fitting: Adjusted-$R^2 = 0.182$							

FA, food addiction; TCI-R, Temperament and Character Inventory—Revised; AUC, area under ROC curve.

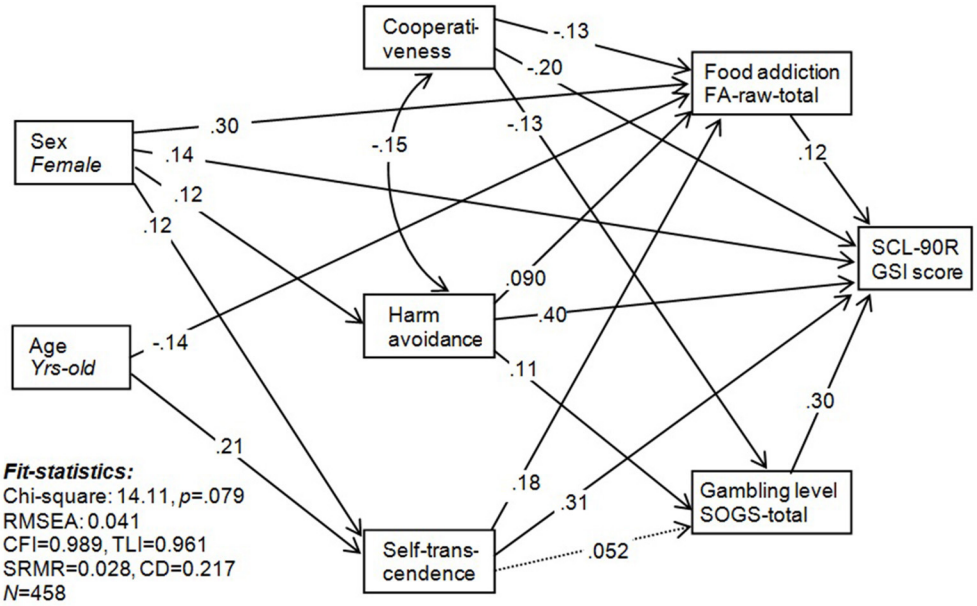

FIGURE 1 | SEM for the pathways between sex, age, personality traits, food addiction, and gambling.

relationships between sex and FA severity, sex and gambling severity, and sex and psychopathological state; and self-transcendence mediated the association between sex, age, and FA severity and psychopathological state. Goodness-of-fit was good for the final model, and the global predictive capacity was high.

DISCUSSION

This study analyzed the frequency of the co-occurrence of GD with FA, and the specific characteristics of this comorbidity compared to GD without FA. The prevalence of FA in the GD sample was 9.7%, with an increased ratio of women compared to men (31.3 vs. 6.9%) and decreasing prevalence at older ages. The comorbidity GD+FA is associated with worse global psychological state than GD only. The risk of obtaining a FA diagnosis was higher for women, patients with younger age and those with higher scores in the personality traits harm avoidance and self-transcendence. Similar results were obtained regarding the FA severity; in addition to the predictors previously described this model indicated an association between low levels of cooperativeness and FA in GD patients.

Scientific literature evidences that FA is more common in women (Pursey et al., 2014) and that it is associated with higher levels of negative affect and depression, and with higher general psychopathology (Granero et al., 2014). Few studies have analyzed the relationship between personality traits and the presence of FA conditions (Wolz et al., 2016) and, to the best of our knowledge, this is the first time that FA is assessed in a clinical GD sample. Personality traits commonly described in GD are high levels of novelty-seeking, low self-directedness and low cooperativeness (Janiri et al., 2007; Álvarez-Moya et al., 2010). Similarly, other studies have demonstrated the relationship between temperament traits like harm avoidance and GD (Nordin and Nylander, 2007; Moragas et al., 2015; Jimenez-Murcia et al., 2016). High levels of harm avoidance is characterized by introspective features and in GD patients, especially women, can lead to the use of gambling as a means of regulating negative affective states (Ledgerwood and Petry, 2006; Stewart and Zack, 2008; Smith et al., 2015; Jimenez-Murcia et al., 2016).

In the current study, when comparing GD+FA with only GD, results showed that mean levels of self-directedness were significantly lower in GD+FA patients. This is consistent with another study, conducted in eating disorder outpatients, showing that FA is strongly related to low self-directedness (Wolz et al., 2016). Moreover, self-directedness is a personality feature described extensively in both GD and other behavioral addictions (Granero et al., 2016a,b), as well as in eating disorders with and without associated behavioral addictions (Moragas et al., 2015). Apart from this, patients with FA were found to have higher scores in self-transcendence (individuals with this personality trait tend to be unconventional, illogical, suspicious, and immature; Cloninger et al., 1998). In this line, previous studies observed that high scores in self-transcendence were a clear predictor of both abuse of and/or dependence on alcohol and drugs, in a sample of GD outpatients (Jiménez-Murcia et al., 2009a). This finding was in agreement with those of other studies carried out in SUD patients (Simmons and Havens, 2007; Herrero et al., 2008). Furthermore, research aimed at the identification of distinct subtypes of GD patients described the existence of a subgroup denominated as "disorganized and emotionally unstable," which is characterized by high impulsiveness and self-transcendence, substance and alcohol abuse and early age of

onset as well as psychopathological disturbances. Interestingly, the presence of women was especially high in this subtype (Álvarez-Moya et al., 2010). In congruence with the results of the present study and the findings described above, Bégin et al. (2012) found that in three groups of women, two of them with overweight/obesity (one with and one without comorbid FA) and a third group with SUD, the groups with overweight/obesity + FA, and SUD were more similar, in terms of personality traits (impulsivity, personality, sensitivity to punishment, and reward, etc.), when compared to the third group with overweight/obesity, but without FA. However, it's worth noting that tobacco use was negatively associated with GD+FA, though this could be reflected by the fact that there were more women in this group.

In addition to the direct associations described above, our analysis has also shown a relationship between these variables (sex, age, and personality traits) and emotional distress (measured by the SCL-90-R).

This pathway suggests that in behavioral addictions, such as GD, there may be a differentiated phenotype of patients, especially young women, presenting addictive-like eating patterns in the context of emotion regulation problems. In fact, various studies conducted with samples of women with GD conclude that gambling is used as a maladaptive way to avoid feelings of frustration, sadness, isolation, and dissatisfaction with their lives (Martins et al., 2008; Fattore et al., 2014; Aymamí et al., 2015; Moragas et al., 2015). Other research identified a direct association between high levels of harm avoidance and psychopathology in women, suggesting that this population might be vulnerable to developing other comorbid disorders (Granero et al., 2009). Therefore, based on the results obtained in this research, it could be postulated that both behaviors (gambling and eating) are dysfunctional strategies that women with GD use to regulate negative emotional states. It is important to note that although FA has not yet been accepted in diagnostic manuals of mental disorders (as in the case of other excessive behaviors like shopping, gaming, etc.; Potenza, 2014) and although it is a controversial issue (Hebebranda et al., 2014; Wolz et al., 2016), the fact that a subgroup of GD patients (mostly women) in addition to their gambling problem suffers from FA demonstrates the importance of exploring the correlates of this condition (Gearhardt et al., 2009).

It is therefore advocated to systematically assess the existence of FA in patients with substance and behavioral addictions and to be especially aware in cases of young women who present overweight or obesity. From a therapeutic point of view, it is necessary to design and implement programs based on holistic interventions that address skills and techniques to improve the two conditions (as in GD with SUD, because of the high co-occurrence). In short, the most relevant issue is to offer problem-solving strategies to the patient, in order to improve self-control, mood state, and quality of life.

Limitations

There are several methodological limitations to this study that need to be taken into account. First, the participants in the sample are only representative of GD patients who seek treatment and therefore the findings obtained may not apply to all individuals with GD. Since few GD individuals seek help for their disorder, a community sample of GD may yield different results. Second, the use of a standardized self-administered questionnaire as assessment procedure did not allow for an in-depth evaluation of specific Axis I and II comorbid disorders. Third, the cross-sectional nature of the study does not allow to conclude if the personality traits found to be related to FA precede or succeed FA symptoms, or if both have one common cause. Moreover, the present study only included one self-report measure of FA, which could be influenced by other variables related to this condition.

CONCLUSION

In sum, the results of this study outline that the comorbid condition of GD with FA is related to a specific phenotype different to that obtained for GD patients without FA. Differences are especially evident for sex and age distribution, and for general psychopathology levels. As a whole, these findings highlight that GD constitutes a heterogeneous condition and that FA should be considered an identifiable and distinct clinical feature with specific clinical outcomes.

The concept of FA needs to be rethought and requires further research. Advanced empirical studies, addressing the etiology and development of FA, as well as to the co-occurrence of FA with other psychiatric mental conditions (such as GD), are needed. Research on neurochemical pathways (for example based on neurobiological models showing overlaps for chemical substances and behavioral addictions) could identify which specific brain regions (prefrontal areas, subcortical structures, and sensory areas) and neurotransmitter systems contribute to the course of non-homeostatic feeding and its association with other behavioral addictions. A better understanding of the mechanisms underlying the onset, clinical profile, and development of the GD+FA comorbidity will allow mental health preventive and intervention services to utilize precise routine assessment tools and adapted treatments for this specific addiction profile (Gearhardt and Corbin, 2011; Sauvaget et al., 2015).

AUTHOR CONTRIBUTIONS

SJ, AG, and FF contributed to the development of the study conceptualization and design. RG performed the formal statistical analysis. MB, IW, GM, TS, and ZA conducted the research and investigation processes of this study, specially data collection. TS, GM, RG, FF, SJ, and AG aided with our interpretation of data. SJ, JM, and FF obtained funding. SJ, RG, AHi, FF, AHa, FC, and CD supervised the study. TS, RG, AG, FF, SJ, and GM were involved in the creation and writing of the initial draft.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg.2017.00473/full#supplementary-material

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Online and Mobile Interventions for Problem Gambling, Alcohol, and Drugs: A Systematic Review

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Online interventions for gambling, alcohol, and illegal drug related problems have been developing at a fast pace over the past decade. Yet, little is known about the content and efficacy of interventions provided entirely online for reducing drug/alcohol use and gambling, or about the characteristics of those who use these interventions. This systematic review aims to describe the characteristics of online interventions, their efficacy, and the profile of their clientele. Documentation was mainly obtained through four scientific databases in psychology, technology, and medical research (PsychINFO, MedLine, Francis, and INSPEC) using three keywords (substances or gambling, intervention, Internet). Of the 4,708 documents initially identified, 18 studies meeting admissibility criteria were retained and analyzed after exclusion of duplicates and non-relevant documents. No study in the review related to problem gambling. The majority of interventions were based upon motivational or cognitive-behavioral theoretical approaches and called upon well-established therapeutic components in the field of addictions. The participants in these studies were generally adults between 30 and 46 years old with a high school education and presenting a high risk or problematic use. More than three quarters of the studies showed a short-term decrease in use that was maintained 6 months later, but only two studies included a 12 months follow-up. Online interventions seem promising and appear to meet the needs of participants who are in the workforce and seeking help for the first time. Long-term efficacy studies should nonetheless be conducted.

Keywords: psychological intervention, Internet, mobile application, addiction, drug, alcohol, gambling

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INTRODUCTION

Substance use disorder, including alcohol and different classes of drugs, can be defined as a group of cognitive, behavioral, and physiological symptoms indicating that an individual continues using the substance despite significant substance-related problems (American Psychiatric Association, 2013). Gambling behaviors activate reward systems similar to those activated by drugs and produce symptoms comparable to those produced by the substance use disorders (American Psychiatric Association, 2013), and Gambling disorder is the only behavioral addiction with sufficient research to be included in the Substance-related and addictive disorders category of the *Diagnostic and Statistical Manual of Mental Disorders* (5th Edn.; *DSM–5*; American Psychiatric Association, 2013).

Systematic reviews of literature report 1 year prevalence rates of 6.6% for alcohol use disorders, 2.4% for other substance use disorders (Somers et al., 2004), and wide variations in past-year problem gambling rates across different countries (0.12–5.8%; Calado and Griffiths, 2016).

Initiating and complying with treatment can be a challenge for clienteles presenting alcohol, drug, or gambling-related problems. In order to overcome the obstacles inherent to psychological interventions and to reduce costs associated with addictions and non-consultation (Sacks et al., 2015), online, and mobile application interventions are developing at a fast pace (Lal and Adair, 2014). What content do they offer to users? Are they effective for reducing drug/alcohol use and gambling? Who is participating in this type of treatment? This systematic review will help to answer these questions.

Even though several psychosocial interventions have shown their efficacy for treating drug, alcohol (Dutra et al., 2008; Magill and Ray, 2009), and gambling disorders (Pallesen et al., 2005; Gooding and Tarrier, 2009), help-seeking rates are low. Only 36% of problem drinkers (Cunningham and Brelin, 2004) and 18% of problem gamblers seek formal assistance (Suurvali et al., 2008). Several obstacles curb help-seeking: need for anonymity or autonomy, shame, and denial (Suurvali et al., 2009; Priester et al., 2016), as well as limited availability (Rockloff and Schofield, 2004) or accessibility of interventions (i.e., scheduling conflicts, transportation difficulties; Clarke, 2007; Priester et al., 2016).

Self-help interventions could help circumvent these obstacles. These interventions are based on self-directed consultation of workbooks which include readings, useful tips and exercises that can be completed at home (Mains and Scogin, 2003; Swan and Hodgins, 2015; Andersson et al., 2016). Based on cognitive-behavioral and motivational approaches (Schmidt and Wykes, 2012; Swan and Hodgins, 2015), self-help interventions may be combined with telephone support provided by a therapist (Mains and Scogin, 2003; Swan and Hodgins, 2015). Several self-help interventions have demonstrated their benefits for treating problem gambling (Labrie et al., 2012; Giroux et al., 2015) and substance use (Carroll et al., 2008; Newman et al., 2011).

Offering self-help material online is a popular alternative in the Internet era. These online interventions first appeared in the 1990s (Childress and Asamen, 1998) and research on the topic multiplied between 2007 and 2010 (Lal and Adair, 2014). According to the findings of two systematic reviews, cognitive-behavioral interventions via computer for various mental health disorders (i.e., depression and anxiety) show an efficacy similar to that of standard face-to-face treatments (Barak et al., 2008) and present a better cost-efficacy ratio (Musiat and Tarrier, 2014). Considering the accessibility of the Internet and the growing popularity of mobile applications, online intervention for substance or gambling disorder could counteract several obstacles related to traditional "offline" services. On-line interventions have the potential to cover large areas at low costs and reach populations that are harder to reach (Barak et al., 2008).

To date, systematic reviews and meta-analyses that targeted the efficacy of online interventions for alcohol, drug, and gambling related problems included several self-help intervention formats (online, telephone, CDRoM, bibliotherapy), delivered alone or in combination, without necessarily differentiating them (for example, Tait and Christensen, 2010; McKellar et al., 2012; Tait et al., 2013; Danielsson et al., 2014; Takano et al., 2015). As such, these studies draw conclusions from a substantial heterogeneity of interventions. Moreover, the inclusion of different types of psychosocial interventions, including preventive interventions, hinders specific observations about interventions targeting the online psychological treatment of addictions. In addition, the participants of these studies have heterogeneous alcohol/drug use and gambling habits; ranging from abstinent, recreational and non-problem users, to those presenting a risk or disorder related to alcohol/drug use or gambling (for example, Tait and Christensen, 2010; Tait et al., 2013). These different participant groups surely have different motivations for signing up for an online intervention program, thus potentially biasing conclusions drawn about the efficacy of these interventions.

Indeed, syntheses on self-help online interventions for addiction do not give a full profile of users participating in online intervention efficacy studies. This information is relevant since these interventions may potentially attract individuals who are not interested in standard interventions (McKellar et al., 2012). For example, Cunningham et al. (2011) showed that at risk alcohol users who completed an online intervention were older, used the Internet more often, and consumed less alcohol during episodes of heavy drinking as compared to those who dropped out of the program. Postel et al. (2011) observed that alcohol users who registered for an online treatment were in greater proportion women, older, more educated, and more likely to be employed and seek treatment for the first time, as compared to those who used a standard treatment.

A literature review pertaining only to online psychological interventions and only to individuals who wish to modify their alcohol, drug, or gambling behavior will help clarify the current state of findings on these interventions. Indeed, a review would shed light on the efficacy of online treatment for drug, alcohol, and gambling problems, and help identify areas of research that need further investigation. Given the diversity of online interventions and technologies developed in recent years, the timing seems appropriate to collect and analyze current available research data. In short, such a review is a step toward better informing public decision-makers, stakeholders and researchers who want to look into new technologies to improve and increase accessibility and adherence to treatments.

The goal of this systematic review is to summarize current knowledge regarding psychological interventions provided entirely online (via computers or mobile applications) for at risk or problem gamblers or users (alcohol, illegal drugs) and that were assessed for efficacy. This review aims to: (a) identify the objectives of the interventions; (b) describe their characteristics (theoretical approach, main components) and modalities (duration, frequency); (c) report the efficacy of interventions in reducing alcohol/drug use and gambling; (d) shed light on participant characteristics; and (e) report the methodological quality of the studies.

MATERIALS AND METHODS

Research Strategies

Studies relating to online treatment of alcohol, drug (excluding prescribed medication) or gambling related problems were identified via the PsycINFO, MedLine, Francis, and INSPEC databases. Two research strategies were used. First, all databanks were searched with three groups of keywords within the entire text:

(gambl* OR "substance misuse" OR "substance abuse" OR "substance addic*" OR "substance dependence" OR "substance related disorder" OR "drug abuse" OR "drug misuse" OR "drug addic*" OR "drug dependence" OR "alcohol abuse" OR "alcohol misuse" OR "alcohol addic*" OR "alcohol dependence") AND (online OR app OR apps OR computer* OR smartphone* OR "mobile phone*" OR virtual OR "mobile device*") AND (treatment* OR intervention* OR therap* OR "online therap*" OR "online intervention*")

Second, PsycINFO database thesaurus and its equivalent in MedLine—the "MESH terms" were used. The group of keywords for the PsycINFO database was:

({Alcohol Abuse} OR {Alcoholism} OR {Drug Abuse} OR {Drug Addiction} OR {Gambling} AND ({Computer Assisted Therapy} OR {Online Therapy})

For the MedLine database, the group of "Mesh terms" was the following:

("Gambling"[Mesh]) OR "Substance-Related Disorders" [Mesh]) AND ("Therapy, Computer-Assisted"[Mesh]) OR "Drug Therapy, Computer-Assisted"[Mesh])

A search conducted on the http://www.clinicaltrial.org site made it possible to obtain references for unpublished studies and to contact their authors when inclusion criteria were met.

Inclusion and Exclusion Criteria

Studies meeting the following criteria were included: (1) written in English or French, (2) published between January 1991 and June 2015 inclusively, (3) involving at least one group whose intervention was entirely online, (4) the intervention targeted the reduction of behaviors or symptoms related to alcohol, drug use, or gambling (5) conducted with users (vs. non-users/abstinents), and (6) used a research design.

Studies were excluded if: (1) the online computer support was used for promoting awareness, prevention (i.e., *personalized feedback*) or strictly for evaluation, (2) the interventions only targeted relapse prevention or consolidation, and (3) they did not include efficacy data.

Article Selection Procedure

Four thousand, seven hundred and eight studies were initially identified, from which 1,204 duplicates were withdrawn. The titles and abstracts of the remaining 3,504 studies were read and 3,220 non-relevant studies were excluded. Upon the second selection round, 284 studies were fully read to verify inclusion and exclusion criteria. The second selection was the subject of an interrater agreement between two evaluators. The evaluators agreed on criteria for 69.3% of the studies, which was considered unsatisfactory. After clarifying the criteria, the evaluators similarly classified 90.3% of the studies, a satisfactory percentage (Lombard et al., 2002). Disagreements were discussed until consensus was reached. Upon completion of the article selection, 18 studies were retained for analysis. **Figure 1** depicts the search process.

Methodological Quality of the Studies

The methodological quality of the studies was evaluated using a list of 11 criteria recommended by the Cochrane Back Review Group (Berger and Alperson, 2009). For a study to be judged as possessing good methodological quality, a minimal threshold of six out of the 11 criteria must be met (Berger and Alperson, 2009). The evaluation scale for each criterion is as follows: *Yes* (+), *No* (−) or *I don't know (?)*. Since four criteria were not applicable within the context of this review, only seven of the proposed criteria were retained and rated. The more a study obtains positive ratings, the more it possesses methodological elements of good quality.

Data Analysis

An extraction grid was developed and filled for each study. The information was collected based on eight themes: (1) type

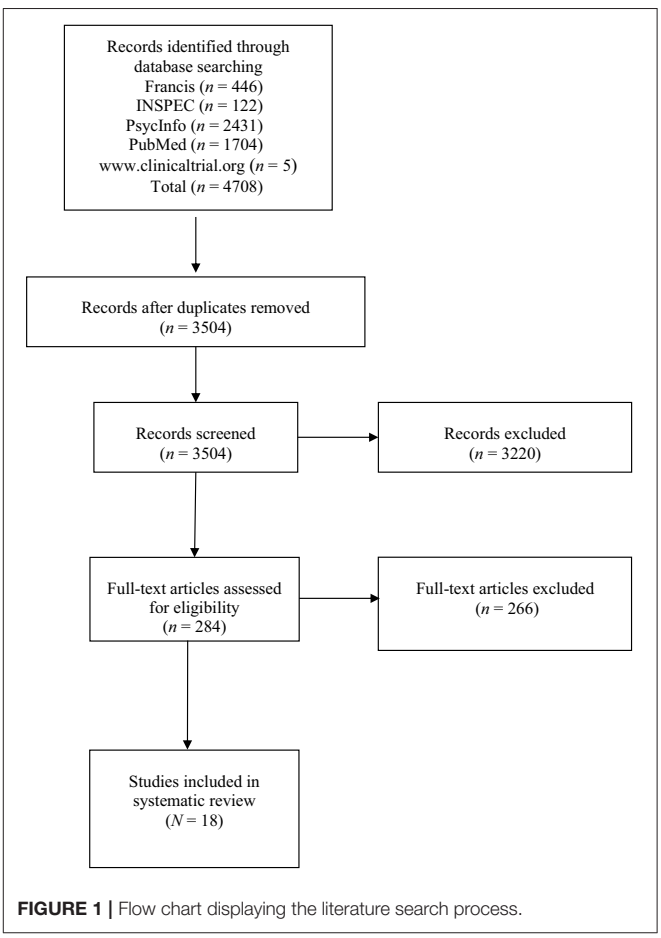

FIGURE 1 | Flow chart displaying the literature search process.

of study, (2) methodology, (3) description of participants, (4) intervention objectives, (5) main findings, (7) conclusion, and (8) methodological quality.

The study coordinator and five psychology doctoral students participated in data extraction. An undergraduate research assistant counter-verified the information extracted for the 18 studies.

RESULTS

Description of Online Interventions

To facilitate the reading of the Results section, the 18 studies are referenced using exponents (see **Table 1**).

Eighteen studies were included in the review and these studies evaluated 22 different interventions in total. Fifteen studies[1 to 15] evaluated 19 interventions for alcohol use. As shown in **Table 1**, 19 interventions are presented for alcohol use since five studies[1, 5, 7, 9, 15] compared the efficacy of two interventions and two studies[12, 13] evaluated the same intervention. The three remaining studies[16, 17, 18] evaluated an intervention relating to drug use (two for cannabis[16, 18] and one for cocaine[17]). No study in the review related to problem gambling.

Three of the 22 interventions[7, 8] are mobile applications for alcohol use, while the others are online interventions (86.4%; [1 to 6, 9 to 18]).

Theoretical Models and Therapeutic Objectives

Thirteen interventions were based, at least in part, upon the cognitive and/or behavioral model (59.1%; [1, 3, 4, 6, 8, 9, 11, 12, 14, 16, 17]), nine upon a motivational approach[1, 4, 6, 9, 11, 14, 17], three upon a solution-focused approach[15, 18], and three upon a relapse prevention model[6, 15, 17]. Self-regulation theories[3, 4, 12, 17] and planned behavior[7] underpin certain interventions, whereas for four interventions[2, 5,10], the theoretical approaches were not indicated.

Of the 22 interventions, 14 (63.6%; [1 to 3, 5 to 7, 9, 10, 12, 15]) targeted decreasing use, seven[4, 8, 11, 14, 16 to 18] offered the choice between decreasing use and abstinence, and only one[9] targeted abstinence.

Techniques and Interventions

The majority of interventions (90.9%; [1 to 6, 8 to 18]) used standard self-help therapeutic material: self-report assessment, self-recordings of use, exercises, readings, and videos. This material aimed, for example, to help the individuals identify at risk situations, determine their goals, modify their thoughts, develop problem solving and emotion management strategies, and to prevent relapse. In addition to this material, four interventions[1, 9, 11, 18] included online chatting with a clinician, and only one[1] involved participating in a discussion forum.

Two interventions via mobile applications differed from the other interventions (9.1%; [7]); the *Check your BAC* and *PartyPlanner App* programs. These interventions enabled users to plan and simulate their alcohol use for a given event and receive an estimate of their blood alcohol levels in real-time.

Intensity

Table 1 describes the intensity of the interventions in terms of total duration, frequency of use and completion time. For three interventions (13.6%; [2, 5, 15]), users' online participation was required only once or twice, whereas the other online interventions lasted between 1 week and 6 months, with suggested utilization of variable frequency (for example, [6, 7, 9, 10, 14, 16, 17]).

Profile of the Online Intervention Participants

The sample characteristics for each of the studies are shown in **Table 2**. A description of the participants is provided for 13 of the 18 studies: For the five other studies, the participants were recruited according to their distinctive characteristics; university students[2, 5, 7], military personnel returning from combat[4] and workers from a certain workplace[10]. These studies were excluded from the general description that follows, but are presented in the targeted clientele section.

Sex and Age

Thirteen studies reported participants' sex. Six of them showed a similar distribution between men and women (46.2%; [1, 8, 11 to 14]), however, a greater proportion of men was found in six studies (46.2%; [3,6,15 to 18]), of which three evaluated an intervention for drug use[16 to 18]. The mean age of the participants from the 12 studies varied between 30 and 46 years[1, 3, 6, 8, 9, 11 to 17].

Education

Three studies did not provide information about education level[3, 14, 16]. Ten studies provided information on level of education, among which eight reported post-secondary studies for 50%[6, 8, 11, 12, 13, 17, 18] to 90%[1] of the participants.

Occupational Status

Six of the 13 studies (46.2%; [1, 6, 8, 11, 12, 13]) indicated occupational status and showed that between 55 and 82% of participants were employed.

Civil Status

Four studies indicated civil status (30.8%; [6, 8, 12, 13]); the proportion of participants in a relationship varied between 35 and 61%[13].

Prior Treatment

Four studies (30.8%; [11, 12, 13, 17]) reported previous treatment, with percentages varying between 4 and 24% of the sample.

Drug/Alcohol Use Problem Severity

The majority of the interventions from the 13 studies (92.3%; [1, 3, 6, 8, 9, 11 to 14, 16 to 18]) were applied to individuals with high-risk use or addiction.

TABLE 1 | Characteristics of Online Interventions (Objectives a and b) According to Type of Problem (Alcohol and Drugs).

Studies	Name/type of intervention(s)	Intervention goal(s)	Theoretical model(s)	Online availability	Intensity (Frequency/Duration/ Completion)	Format (Techniques/Exercises)
PROBLEM: ALCOHOL						
[1]Blankers et al. (2011)	Self-help Alcohol Online (SAO)	↓ Use	CBT Motivational	Computer Smart phone	Each day (variable)/At any time/–	*Four modules*: Self-observation and self-recording of use, goal setting, personalized feedback, relapse prevention and motivational strategies, discussion forum among participants
	Therapy Alcohol Online (TAO)	↓ Use	CBT Motivational	Computer Smart phone	1 session per day/7 days/40 min per session	*Therapy sessions with a CBT therapist:* Self-recording, goal setting, self-control, management of at-risk situations, urge to drink and emotions, relapse prevention, and consolidation of gains
[2]Braitman (2012)	Alcohol 101 + Booster	↓ Use	–	Computer	Once/–/60 min	*Psychoeducation and interactive virtual campus:* Psychoeducation, normative personalized feedback, strategies relating to attitudes toward alcohol, interpersonal skills. Booster after 2 weeks: feedback
[3]Brendryen et al. (2014)	Balance (self-treatment on alcohol)	↓ Use	Self-regulation CBT	Computer	–/62 sessions over 6 months/3–10 min per session	*62 sessions:* Assessment of use and normative personalized feedback, goal setting, emotional regulation, psychoeducation, relapse prevention, interactive tasks, homework
[4]Brief et al. (2013)	VetChange	↑ Motivation Skills for safe use / cease use	Motivational Self-control CBT	Computer	1 module per week / 8 weeks / 20 min per module	*Eight modules*: Personalized feedback, decisional balance and goal setting with a change plan, at-risk situation management, strategies for managing internal difficulties leading to use, support network development
[5]Carey et al. (2011)	Alcohol 101 plus	↓ Use	–	Computer	Once/–/Minimum 60 min	*Psychoeducational and interactive virtual campus:* Decision-making relating to use, psychoeducation and knowledge test about alcohol
	Alcohol Edu for Sanctions	↓ Use	–	Computer	Two times/–/2 h (1 h/time)	*Five chapters*: Interactive exercises, personalized feedback, quiz questions and risk assessment 1 month later: Reflections about one's personal experience and consolidation of gains
[6]Cunningham (2012)	Check Your Drinking + Alcohol Help Center	↓ Use	Motivational CBT Relapse prevention	Computer	–/Repeated use (–)/–	*Three modules*: Personalized feedback, exercises to initiate change, problem-solve, and consolidate gains, complementary but optional tools
[7]Gajecki et al. (2014)	PartyPlanner App.	↓ Use	Planned behavior	Mobile application	Variable/5–6 weeks/–	*Simulator and estimate of blood alcohol level:* Before and after, comparison of planning to estimate of the real drinking episode
	Check your BAC	↓ Use	Planned behavior	Mobile application	Variable / 5–6 weeks /–	*Blood alcohol level estimate:* Feedback of estimated blood alcohol level in real-time, strategies to maintain use at a not-at-risk level and psychoeducation

(Continued)

TABLE 1 | Continued

Studies	Name/type of intervention(s)	Intervention goal(s)	Theoretical model(s)	Online availability	Intensity (Frequency/Duration/ Completion)	Format (Techniques/Exercises)
[8]Gonzalez and Dulin (2015)	Location-Based Monitoring and Intervention for Alcohol Use Disorders	↓ or cease use	CBT	Mobile application	–/6 weeks/15 min per psychoeducational component, variable for the tools	*Seven modules:* Psychoeducation, personalized feedback, and tools: identification of at-risk situations, of support network and of alternative pleasant activities, craving management, problem-solving and communication skills, exercises
[9]Hester et al. (2013)	SMART Recovery	–↑ motivation and healthy lifestyle –↓addictive behaviors	Motivational CBT	Computer and/or face-to-face	Variable/Variable/Variable	*Online resources comprised of 4 components and meetings with a therapist:* Craving management, thoughts-emotions-behavior links, balanced lifestyle, and relapse prevention
	Overcoming Addictions	Achieve and maintain abstinence	Motivational CBT	Computer	Minimum once per week/Variable/Variable	*Five modules:* Self-recording, exercises, psychoeducation, craving, and relapse management, relapse prevention, cognitive correction, problem-solving, and balanced lifestyle
[10]Matano et al. (2007)	CopingMatters	↓ Use	–	Computer	Variable/max. 90 days/–	*Moderated and interactive Internet:* Personalized feedback (limited or complete), advice, psychoeducation, interactive exercises, self-recording
[11]Postel et al. (2010)	E-therapy program (Alcohol de BAAS)	↓ or cease use ↑ Health indicators	CBT Motivational	Computer/Device with Internet connection	Every day and 1–2 contacts online with a therapist/90 days/–	*Two parts*: Decisional balance, self-recording, questionnaires about use, personalized advice, thought, and behavior modification, problem-solving, consolidation of gains, relapse prevention
[12]Riper et al. (2008)	Drinking Less	↓ Use	CBT Self-control training principles	Computer/Mobile device	–/6 weeks/15 min (stages 1–2) and–(stages 3–4)	*Internet site (4-step program):* psychoeducation, Decisional balance, goal setting, behavior change, consolidation of gains, relapse prevention, exercises and self-recording
[13]Riper et al. (2009)						
[14]Sinadinovic et al. (2014)	CBT-based online extended self-help intervention (Alkoholhjalpen.se)	↓ Use	Motivational CBT	Computer	Variable/Variable/Variable	*Internet site (18 modules):* Identification of at risk situations, decisional balance, relapse prevention, psychoeducation, interactive exercises, questionnaires, and personalized recommendations
[15]Tensil et al. (2013)	Change Your Drinking (original version)	↓ Use	Solution-focused	Computer	Once/10 days/–	Alcohol use journal, objectives, psychoeducation, control strategies, and personalized feedback
	Change Your Drinking (revised version)	↓ Use	Solution-focused CBT Relapse prevention	Computer	–/14 days/–	*Additions*: Identification of at-risk situations, self-control strategies, simple motivational feedback, more elaborate personalized feedback
PROBLEM: DRUG						
[16]Rooke et al. (2013)	Reduce Your use: How to Break the Cannabis Habit	↓ Use cease use (cannabis)	CBT	Device with Internet connection	–/6 weeks/–	*Six modules:* Psychoeducation, withdrawal management, identification of dysfunctional thoughts, adjustment strategy and social skills learning, consolidation of gains, relapse prevention, feedback

(Continued)

TABLE 1 | Continued

Studies	Name/type of intervention(s)	Intervention goal(s)	Theoretical model(s)	Online availability	Intensity (Frequency/Duration/Completion)	Format (Techniques/Exercises)
[17] Schaub et al. (2012)	Snow Control	↓ Use or cease use (cocaine)	CBT Motivational Self-control Relapse prevention	Computer	–/6 weeks/–	*Internet site (program comprised of 8 modules and 4 supplementary modules)*: Psychoeducation, decisional balance, identification of at-risk situations, management of urge to use, relapse, free time, saying no skills, and consolidation of gains
[18] Tossman et al. (2011)	Quit the Shit	↓ Use or cease use (cannabis)	Solution-focused	Computer	–/50 days/Steps 1–4: –, 2: 50 min, 3: 50 days	*4-step program*: Initial evaluation through chat with a therapist, goals for ↓ use and management strategies, self-recording, feedback through chat with a therapist, use management strategies

–, Information absent from the article; ↓, Decrease; ↑, Increase/Improvement; CBT, Cognitive-behavioral theory; FAST, Fast Alcohol Screening Test; max., maximum.

Participants through Targeted Recruitment from a Population

University students[2, 5, 7]

The participants were young adults, aged on average between 19[5] and 25 years[7], studying full-time. Thirteen studies reported the sex of participants. Six reported an even distribution of men and women (46.2 %; [1, 8, 11 to 14]), however, a majority of men were found in six studies (46.2 %; [3, 6, 15 to 18]), including the three studies evaluating a drug-related intervention. One study[2] indicated that 4.6% of students received prior treatment and another[7] showed at risk alcohol use among participants.

Military personnel returning from combat[4]

The participants were men (86%) who had received a prior psychological treatment (61%) and who presented problematic alcohol use.

Workers from a targeted workplace[10]

All the participants were employed, the majority were women (78%) and had completed university studies (84%).

The Efficacy of Online Interventions

Table 2 presents the efficacy of the interventions for bringing changes on at least one substance use indicator (i.e., frequency of use per week or month, amount of use per occasion).

Short-Term Efficacy

Fifteen of the 18 studies (83.3%; [1 5, 7 to 11, 14 to 18]) evaluated post-intervention changes in substance use. These evaluations took place immediately after the intervention or within a delay varying between 2 weeks and 3 months after initial evaluation. The duration of the interventions being variable within a same study and between studies, the evaluation that takes place 3 months after initial evaluation could be considered close to the end of the intervention.

Eleven studies reported a significant decrease on at least one substance use indicator for the group receiving the online intervention, seven as compared to a control group without intervention[1, 2, 4, 5, 11, 16, 18], two as a group receiving another type of intervention[8, 10], and two without a control group[9, 15]. However, four studies obtained mitigated results: a significant decrease in severity of alcohol related problems among all participants, including those in the group that received no intervention[14], very limited efficacy[17], or absence of efficacy[3] as compared to a group without intervention, and even a lack of efficacy with an increase in substance use episodes among men[7].

Medium and Long-Term Efficacy

Eight of the 18 studies (44.4%; [1, 3, 5, 6, 12, 13, 14, 17]) included a 6-month post initial evaluation follow-up. Overall, these studies showed the maintenance of improvements observed shortly after intervention. Only two studies[5, 14] evaluated the maintenance of gains 12 months after the initial evaluation, of which one[5] showed that the gains were maintained exclusively for women, whereas the other[14] study showed maintenance of improvements for all groups, including the group who did not received intervention.

TABLE 2 | Description of the Efficacy Studies and the Sample (Objectives c and d) According to Type of Problem (Alcohol and Drugs).

Study	Principal study objective(s)	Experimental conditions *(n)*[a] and assessment times	Sample characteristics (mean age, % women, education, % employed, civil status, % prior treatment, problem severity)[a]	Instruments used[b]	Main findings
PROBLEM: ALCOHOL					
[1]Blankers et al. (2011)	Compare the efficacy of a therapy provided on the Internet and a self-administered treatment via Internet among problematic drinkers	Internet therapy (IT; *68*) Internet self-administered therapy (IST; *68*) Waiting List (WL; *69*) Initial evaluation (T0) 3 and 6 six months after T0	For IT, IST, and WL respectively: *Age:* 41.9 (10.1); 41. (9.6); 43. (9.3) *% women:* 51; 51; 49 *% post sec. education: 97; 94; 89* *% employed:* 85; 82; 78 *Severity: M(SD) on the AUDIT*[c]: 18.8 (4.8); 19.6 (5.6); 20.1 (4.9)	AUDIT TLFB (7 days)	3-month follow-up: significant ↓ on the AUDIT and TLFB among participants from the IT and IST vs. those from WL. 6-month follow-up: IT group improved more than the IST group.
[2]Braitman (2012)	Evaluate the ability of a follow-up session to increase the efficacy of an intervention conducted via computer among university students	Alcohol 101*(181)* Alcohol 101+ (*172*) Control (*39*) Initial evaluation 2-week and 4-week follow-up	*% women*: 65.1 *% full-time students*: 96.7 *% single:* 71.9 *% prior treatment:* 4.6	DDQ	At 2-weeks, no difference between the conditions. At 4-weeks, Alcohol 101+ significantly ↓ number of days of use, quantity of alcohol/occasions and blood alcohol level/day of heavy drinking.
[3]Brendryen et al. (2014)	Compare the efficacy of two versions of the *Balance* intervention (brief/intensive self-treatment) on alcohol use	Intensive self-treatment (*125*) Brief self-treatment (*119*) Initial evaluation 2- and 6-month follow-ups	Intensive self-treatment and brief self-treatment, respectively: *Age:* 39 (14); 37 (13) *% women:* 30; 36 *Severity:* M(SD) on the *FAST*[d]: 6.3 (3.0); 6.2 (2.8)	FAST Daily alcohol use	2-month follow-up: no difference between the groups. 6-month follow-up: *Intensive* group ↓ its use more.
[4]Brief et al. (2013)	Evaluate the efficacy of a web-based intervention for drinking among military personnel returning from combat	Intervention (*404*) Control *(193*) Initial evaluation Post-intervention 3-month follow-up	Intervention and Control, respectively: *% women:* 13.9; 13.3 *% prior treatment (N):* 61 *Severity:* M(SD) on the AUDIT: 17.7 (4.8); 17.6 (4.7)	AUDIT QDS (Qty and frequency of use)	Post-intervention: Intervention group significantly ↓ alcohol use. 3-month follow-up, the intervention group continues to significantly ↓ alcohol use.
[5]Carey et al. (2011)	Evaluate the efficacy of an intervention for alcohol use among students to verify if a brief motivational intervention (BMI) is more effective than that on the Web	Face-to-face BMI (*164*) Alcohol 101+ (*172*) Alcohol Edu (*167*) Wait-list (*174*) Initial evaluation 1-, 6- and 12-month follow-ups	*Age:* 19 (0.71) *% women:* 36 *% university students:* 100	DDQ (drinks / week)	1 month: BMI = better results than for Alcohol 101+ and Edu. The men significantly ↓ their use in the three groups vs. only women in the BMI group. 12-months: maintenance for all groups (except for the women).
[6]Cunningham (2012)	Evaluate the efficacy of a bonified *Alcohol Help Center* (ACH) online intervention vs. a validated brief online intervention *Check your drinking* (CYD)	AHC Group (*83*) CYD Group (*87*) Initial evaluation 6-month follow-up	*Age:* 45.2 (12.2) *% women:* 40.6 *% post-sec. education:* 58.8 *% in a relationship:* 39 *% employed*: 55 *Severity:* M (SD) on the AUDIT: 22.1 (7.6)	AUDIT AUDIT-C Daily alcohol use	6-month follow-up: significant ↓ on the AUDIT and in daily use for both groups - Significantly greater ↓ in number of drinks / occasion for the AHC group.
[7]Gajecki et al. (2014)	Evaluate the efficacy of two applications among students and to explore differences between the sexes.	Check your BAC (*643*) PartyPlanner app. (*640*) Control (*649)* Initial evaluation 7-week follow-up.	*Age:* 24.7 (4.8) *% women:* 51.7 *Severity:* M (SD) on the AUDIT: 10.7 (3.9)	AUDIT DDQ (qty-frequency/ month) eBAC	7-week follow-up: the BAC group significantly ↑ the frequency of occasions to drink vs the control group. This difference is significant for men only.

(Continued)

TABLE 2 | Continued

Study	Principal study objective(s)	Experimental conditions (*n*)[a] and assessment times	Sample characteristics (mean age, % women, education, % employed, civil status, % prior treatment, problem severity)[a]	Instruments used[b]	Main findings
[8]Gonzalez and Dulin (2015)	Compare the efficacy of the *Location-based Monitoring and Intervention for Alcohol Use Disorders* application (LBMI-A) to an online motivational intervention *Drinker's Check-up* + bibliotherapy (DCU-BT)	1-LMBI-A (*31*) 2-DCU-BT (*29*) Initial evaluation 6-week follow-up	LMBI and DCU, respectively *Age:* 33.6 (6.5); 34.3 (6.2) *% women:* 46.4*; 35 *% post-sec. education:* 42.9; 50 *% in a relationship:* 39.3; 35 *% employed:* 78.6; 65 *Severity:* M (SD) *DSM-5criteria:* 7.1 (2.0)*; 5.6 (1.9)	DSM-5 criteria TLFB	6-week follow-up: Only the LMBI-A group reported a significant ↑ in number of days abstinent. For both groups: significant ↓ in number of drinks/week and % of days of heavy drinking, but the effect is greater for the LBMI-A.
[9]Hester et al. (2013)	Evaluate the clinical efficacy of the Overcoming Addiction (OA) and the SMART Recovery (SR) online programs for ↓ drinking and its consequences	1- OA (*19*) 2- OA + SR meeting (*83*) 3- SR meeting (*87*) Initial evaluation 3-month follow-up	*Age;* 44.3 (10.9) *% women:* 60.6 *M (SD) years of education:* 16.1 (2.4) *Severity:* M (SD) on the AUDIT: 24.7 (8.1)	TLFB InDUC	3-month follow-up: All groups show significant ↑ in % of days abstinent, significant ↓ in number of drinks/day and significant ↓ on InDUC score. - ↑ in number of meetings = ↑ number of days abstinence and ↓ in problems.
[10]Matano et al. (2007)	Evaluate the efficacy of an online educational program aiming a ↓ in alcohol use in a work environment for low/moderate risk drinkers	Limited feedback Complete feedback (*N = 173*) Initial evaluation 3-month follow-up	*Age:* 39.9 (11.3) *% women:* 77.9 *% no university education:* 16.1 *% employed:* 100 *% in a relationship:* 46.2	AUDIT Self-reported alcohol use	3-month follow-up: significant ↓ of heavy drinking episodes for those receiving complete feedback, both for *low and moderate risk* individuals.
[11]Postel et al. (2010)	Evaluate the efficacy of an online program involving a therapist for an alcohol use related problem.	e-therapy (*78*) Control (*78*) Initial evaluation 3-month follow-up	*Age:* 45.3 (9.8) *% women:* 53.8 *% post-sec. education:* 57.7 *% employed:* 82.1 *% prior treatment:* e-therapy: 24; control: 4* *Severity:* % Dependence: 81.4, Abuse: 10.3	TLFB (7 days) *Diagnostic Interview* of the DSM-IV-TR (*Substance abuse module)*	3-month follow-up: *e-therapy* group significantly ↓ drinking/week vs. control group. - 68% of *e-therapy* under the threshold for problematic use vs. 15 % of control group (sign. difference).
[12]Riper et al. (2008)	Verify the efficacy of a self-administered online intervention (Drinking Less; DL) for ↓ drinking	DL Group (*130*) Control (psychoeducational handout; *131*) Initial evaluation 6-month follow-up	DL and control, respectively: *Age:* 45.9 (8.9); 46.2 (9.2) *% women:* 49.2; 48.9 *% post-sec. education:* 68.5; 71 *% in relationship:* 57.7; 54.2 *% employed:* 72.3; 73.3 *% prior treatment:* 12 *Severity (% problem):* 100	Self-reported alcohol use (7 days)	6-month follow-up: significantly more participants in DL group are low risk, vs. the control group. DL group significantly ↓ in drinks/week.
[13]Riper et al. (2009)[f]	Verify if the results of a controlled randomized study by Riper et al. (2008) in regards to the DL intervention are generalizable to the general population (DL-pop)	DL (*130*) DL-pop (*378*) Initial evaluation 6-month follow-up	DL-pop alone [g]: *Age:* 44,3 (10.5) *% women:* 52.6 *% post-se. education:* 54.7 *% in relationship:* 61.4 *% employed:* 82.3 *% prior treatment:* 16.4 *Severity (% problem):* 95.2	AUDIT Self-reported alcohol use (7 days)	Results for the DL-pop group are comparable to those found for the DL group in Riper et al. (2008).

(Continued)

TABLE 2 | Continued

Study	Principal study objective(s)	Experimental conditions (*n*)[a] and assessment times	Sample characteristics (mean age, % women, education, % employed, civil status, % prior treatment, problem severity)[a]	Instruments used[b]	Main findings
[14]Sinadinovic et al. (2014)	Compare an online CBT intervention to online personalized feedback (eScreen.se) and a control group for alcohol related problems	CBT (*212*) Feedback (*211*) Control (*210*) Initial evaluation 3-, 6-, 12-month follow-ups	CBT, Feedback and Control, respectively: *Age:* 43.8 (11.9); 44 (13.6); 44.1 (12.1) *% women:* 55.7; 55; 54.3 *Severity: Mean score on the AUDIT*: 20.1; 21.5; 20.9	AUDIT AUDIT-C	3-month follow-up: all groups show a significant ↓ on AUDIT and AUDIT-C; scores remain stable at 6- and 12 months.
[15]Tensil et al. (2013)	Evaluate whether the revised version of *Change Your Drinking* (CYD) is more efficacious than the CYD-original	CYD-original (*300*) CYD- revised (*295*) Initial evaluation 6-week and 3-month follow-ups	CYD-o and CYD-r, respectively: *Age:* 29.8 (10.3); 29 (9.4) *% women:* 41; 36.6 *% post-sec.:* 32.3; 37.6 *% prior treatment:* 10.3 *Severity: APS score M (SD)*: 2.4 (1.8); 2.3 (1.7)	APS Self-reported alcohol use (7 days)	3-month follow-up: Both groups show ↓ in number of days of use/week, qty of alcohol, number of episodes of heavy drinking, with no difference between the two interventions.
PROBLEM: DRUGS					
[16]Rooke et al. (2013)	Evaluate the efficacy of an online program for ↓ or ceasing cannabis use	Intervention (*119*) Control (*111*) Initial evaluation 6-week and 3-month follow-up	Intervention and control, respectively: *Age:* 31.9 (9.6); 30.2 (9.6) *% women:* 40.3; 36.8 *Severity SDS M (SD):* 14 (3.6); 13.8 (3.6)	SDS GAIN-I TLFB (past month)	6-week follow-up: The Intervention group presents a significant ↓ in days of use, quantity used and symptoms of abuse. Maintenance at 3-month follow-up.
[17]Schaub et al. (2012)	Evaluate the efficacy of an online program to control or cease cocaine use	Intervention (*96*) Control (*100*) Initial evaluation 4-, 6- week and 6-month follow-up	*Age:* 34.2 (8.8) *% women:* 21.9 *% post-sec. education:* 75 *% prior treatment:* 20.4 *Severity SDS M (SD):* 8.0 (3.1)	SDS Cocaine use journal	The number of days of abstinence did not change after the intervention, but the quantity of cocaine used ↓ for both groups.
[18]Tossman et al. (2011)	Verify the efficacy of an online program for ↓ cannabis use.	QTS (*863*) Control (*429*) Initial evaluation 3-month follow-up	*Age:* 24.7 (6.8) *% women:* 29.5 *Education (% completed high-school and college):* 58.7 *Severity (%): DSM-IV - dependence:* 92	Dx criteria of the DSM-IV Self-reported cannabis use	At 3-month follow-up, the QTS significantly ↓ number of days of use.

*TAO, Therapy Alcohol Online; SAO, Self-help Alcohol Online; M, mean (or mean score); SD, Standard deviation; Sec., secondary; –, Information missing from the article; AUDIT, Alcohol Use Disorders Identification Test; TLFB, Timeline Follow Back technique: Self-reported measure of standard alcohol consumption within a time frame X preceding evaluation; DDQ, Daily Drinking Questionnaire; Significantly = $p < 0.05$; vs., versus; ↓, Decrease; ↑, Increase / Improvement; Qty, Quantity; FAST, Fast Alcohol Screening Test; QDS, Quick Drink Screen; eBAC, estimated blood alcohol concentration; *Statistically significant difference $p < 0.05$; DSM-5, Diagnostic and statistical manual of mental disorders, 5th edition; InDUC, Inventory of Drug Use Consequences: APS, Alcohol-related Problem Scale (no threshold). SDS, Severity of Dependance Scale; GAIN-I, Global Appraisal of Individuals Needs-Initials.*

[a]*Information gathered at the time of the initial evaluation. When available, information for the overall sample is provided. The characteristics for which no information was provided in the study is absent from the grid.*

[b]*Only instruments used to evaluate the severity of problematic use (alcohol or drugs) and changes in use (quantity-frequency) are reported.*

[c]*On the AUDIT, a score equal or superior to 8 indicates at-risk (at least) alcohol use.*

[d]*On the FAST, scores vary between 0 and 16. A score superior to 2 indicates at-risk alcohol use.*

[e]*This efficacy study pertains to the same intervention as in Dulin et al. (2014).*

[f]*This efficacy study pertains to the same intervention as in Riper et al. (2008).*

[g]*Only the characteristics of the participants from the DL-RW group are presented. See Riper et al. (2009) for those of the DL-RTC group.*

Methodological Quality of the Studies

Table 3 presents the evaluation of the studies based on the seven criteria in decreasing order of methodological quality score. Nine studies met six criteria (50%; [4, 6, 7, 9, 14 to 18]), two satisfied five criteria[3, 12], and six met four criteria[1, 2, 8, 10, 11]. One study met only two criteria[13]. Half of the 18 studies[2, 3, 5, 6, 8, 10, 12, 13, 16] presented insufficient information to determine if they met at least one criterion.

DISCUSSION

The goal of this systematic review is to portray psychological interventions that are entirely online for people with alcohol, drug, and gambling related problems.

Like the systematic review conducted by Danielsson et al. (2014), this review shows that studies evaluating the efficacy of online interventions for alcohol related problems are more numerous than those for illegal drugs and gambling. Moreover, no efficacy study on a completely online intervention for problem gambling was retained for this study. With its systematic approach, this review highlights the glaring lack of research on the effectiveness of online or mobile applications to help individuals with gambling problems. Online interventions for gamblers were identified, but they were excluded for three main reasons. First, they targeted gambling prevention (personalized feedback) or addressed a student clientele without a gambling problem (for example, Hopper, 2008; Lostutter, 2009). Personalized feedback interventions are closer to secondary prevention than pure psychological intervention to reduce or eliminate an undesirable behavior (Hopper, 2008; Palfai et al., 2014). For the most part, these interventions do not target a specific clientele, as they include non-consumers with high-risk consumers (for example, Cunningham et al., 2006; Doumas and Andersen, 2009; Bewick et al., 2010; Labrie et al., 2013), with the goal to keep their consumption within recommended limits. Nevertheless, these personalized feedback interventions represent an innovative way of raising awareness about the participants' own consumption and may in some cases lead to changes in behavior. Second, these interventions were not offered completely online, as some studies included a telephone contact with a clinician (for example, Carlbring and Smit, 2008). Third, they did not present data about efficacy, like the preliminary study of satisfaction with an entirely online intervention for excessive gambling (see Zermatten et al., 2010). It would be important to prioritize to research into the use of new technologies in the treatment of problem gamblers, considering that standard "offline" self-help treatment programs are effective in reducing negative consequences of excessive gambling behavior (Hodgins et al., 2001, 2009; Giroux et al., 2015), but may not be easily accessible to gamblers. It thus appears necessary to empirically evaluate the efficacy of online interventions dedicated to problem gamblers.

The large majority of online interventions for alcohol or drugs were delivered on a web platform, with the exception of three mobile applications. Two of these applications (see Gajecki et al., 2014) differ from the other interventions in regards to their theoretical approach, that of planned behavior (Ajzen, 1991), and their content, which consisted of a behavioral tool to manage alcohol use and estimate blood alcohol levels in real time. Such interventions show that technological advances can potentially diversify intervention tools for users. Yet, as the review suggests, these interventions may lead to undesirable effects such as an increase in substance use occasions. These findings support the need to rigorously evaluate their efficacy and to require the same quality standards as for face-to- face treatments.

In regards to the therapeutic objectives targeted by online interventions, the majority of them offer a freedom of choice to the users as to goals of decreasing use or abstinence. They also offer users flexibility when targeting goals for decreased alcohol/drug use. Imposing abstinence may discourage many users from seeking assistance (Ursúa, 2008) and favor treatment withdrawal, even before treatment begins (Andrewartha and Dowling, 2006). The flexibility offered by online interventions

TABLE 3 | Methodological Quality of the Studies According to Seven of the Eleven Criteria of the *Cochrane Back Group Criteria List* (objective e), According to Type of Problem (Alcohol and Drugs).

Study	Criterion[a]							
	A	B	C	H	I	J	K	Total
PROBLEM: ALCOHOL								
[4]Brief et al. (2013)	+	+	+	+	−	+	+	6
[6]Cunningham (2012)	+	+	+	?	+	+	+	6
[7]Gajecki et al. (2014)	+	+	+	+	−	+	+	6
[9]Hester et al. (2013)	+	+	+	−	+	+	+	6
[14]Sinadinovic et al. (2014)	+	+	+	+	−	+	+	6
[15]Tensil et al. (2013)	+	+	+	+	−	+	+	6
[3]Brendryen et al. (2014)	+	+	?	+	−	+	+	5
[12]Riper et al. (2008)	+	?	+	+	−	+	+	5
[1]Blankers et al. (2011)	+	+	+	−	−	−	+	4
[2]Braitman (2012)	+	+	?	+	−	+	?	4
[5]Carey et al. (2011)	?	?	+	+	+	+	?	4
[8]Gonzalez and Dulin (2015)	−	−	+	+	+	+	?	4
[10]Matano et al. (2007)	+	?	+	+	+	−	−	4
[11]Postel et al. (2010)	+	+	+	+	−	−	+	4
[13]Riper et al. (2009)	−	−	?	+	−	−	+	2
PROBLEM: DRUGS								
[16]Rooke et al. (2013)	+	+	+	+	+	?	+	6
[17]Schaub et al. (2012)	+	+	+	+	−	+	+	6
[18]Tossman et al. (2011)	+	+	+	+	−	+	+	6

+, Yes (criterion met); −, No (criterion not met); ?, Don't know (no indicator in the text making it possible to determine if the criterion is met).

Criterion A: Was the method of randomization adequate?

Criterion B: Was the treatment allocation concealed?

Criterion C: Were the groups similar at baseline regarding the most important prognostic indicators?

Criterion H: Was the compliance acceptable in all groups?

Criterion I: Was the dropout rate described and acceptable?

Criterion J: Was the timing of the outcome assessment in all groups similar?

Criterion K: Was the intent-to-treat analysis performed?

[a]*The criteria D (Was the patient blinded to the intervention?), E (Was the care provider blinded to the intervention?), F (Was the outcome assessor blinded to the intervention?) and G (Were cointerventions avoided or similar?) were not evaluated because of difficulties applying them to the studies reviewed.*

may favor treatment adherence and even lead to a change of therapeutic objective toward abstinence, as observed in a large portion of the sample of gamblers receiving face-to-face treatment in the study conducted by Ladouceur et al. (2009).

The majority of online interventions are based on cognitive-behavioral or motivational approaches; approaches underpinning standard and self-administered psychological treatments for gambling and alcohol/drug related problems (Dutra et al., 2008; Cowlishaw et al., 2012; Martin and Rehm, 2012). These two approaches are recognized as efficient for addiction treatment and their structure, as well as the techniques used, appear to be easily adaptable to an online format (Gainsbury and Blaszczynski, 2011). This review suggests that for several interventions, the full potential of a web platform does not appear to be exploited. Indeed, with the exception of only a few interventions, the techniques and tools used appear to be mostly replicas of what is already offered offline. Only 18.2% of the interventions used an online chat room, while 4.5% offered an online support forum; these tools are very easy to set up, but the content needs to be supervised by a professional. As for mobile application interventions, they tend to exploit the originality of new technologies but may possibly lead to undesirable effects among certain participants; for example, an increase in use in order to use the mobile application more frequently, to see how much their blood alcohol level could rise. Rethinking the way these apps are engineered could help with this novelty effect.

Contrary to standard cognitive-behavioral treatments that give priority to a clear therapeutic framework (Andersson et al., 2016), this review shows that the suggested utilization of the online interventions for participants is variable, or even provided without any defined indicators. The flexibility of the therapeutic framework is typical of self-administered interventions, although those offered offline generally suggest a certain treatment intensity (Simoneau et al., 2004; for example, Carroll et al., 2008; Ladouceur et al., 2015). The malleable and little demanding framework of online interventions may counterbalance obstacles to entering treatment (Priester et al., 2016), but is susceptible to give rise to variable commitment and utilization.

This review made it possible to extract a profile of participants of online interventions for drug and alcohol use outside of targeted recruitment. Overall, the participants are mostly adults between 30 and 46 years old who are educated and employed. Although less than a quarter of the clientele reported having previously consulted for drug or alcohol related problems, the majority was identified as presenting problematic drug/alcohol use.

This profile appears similar to that drawn by Postel et al. (2011). The *online* format attracts adults between 30 and 46 years old, which indicates that this clientele may be more receptive to technological advances because of their active and regular Internet use (Ducharme, 2015). Users who utilize online interventions generally appear to be educated. This is consistent with the proposed type of interventions, which require reading, writing, and computer skills (Farrer et al., 2014). The high proportions of workers may also indicate that the flexibility offered by online interventions fits well within a busy life schedule. Studies show that a higher level of education (Spek et al., 2008) and being employed (de Graaf et al., 2010) are predictors of success on online cognitive-behavioral interventions for depression. The same may apply to interventions for drug and alcohol users, but further studies would be needed to verify this hypothesis. Finally, the fact that few participants had previously consulted suggests that online interventions are attractive for first time consultations; they may demystify treatment and act as a stepping stone toward other more intensive intervention modalities (Bower and Gilbody, 2005).

The online interventions generally seem to be efficacious for reducing certain drug and alcohol use behaviors on a short-term basis. The majority of the studies report positive results on at least one substance use indicator following intervention, and some show a medium term maintenance of gains. These results appear to be coherent with other studies evaluating the efficacy of offline self-help treatments (Hodgins et al., 2009; Giroux et al., 2015). However, few studies in the review evaluate long-term changes and those that do, report little conclusive findings. It thus remains difficult to draw conclusions about the long-term benefits of online interventions for problematic use of drugs/alcohol. These results point to the relevance of including longer-term follow-ups to verify the maintenance of gains over time.

This review presents some limitations. One of them relates to the difficulty of the review to meet the final research objective, that of presenting the methodological quality of the studies. Indeed, even though this grid used Cochrane recommended criteria, the evaluation grid used required the withdrawal of nearly a third of the tool's criteria because of the difficulty applying them to the types of studies identified. Another limitation relates to the subjective portrait offered by the review regarding the efficacy of the online interventions since the review's inclusion criteria, as well as the study objectives, did not make it possible to conduct a meta-analysis.

The review does however possess strengths, notably the scientific rigor employed during the study selection and database extraction processes. A second strength lays in the selection of interventions included in the review; those available entirely online. By differing from the review of Danielsson et al. (2014) that included different intervention modalities, alone or in combination, the present review draws a more homogenous portrait. However, the studies evaluating online interventions for problem gamblers were excluded and the conclusions offered cannot be generalized to this population. To draw a portrait of the users recruited from the general population represents another strength of the review, in that it provides support to empirical studies that have already conducted this exercise and makes it possible to identify the clientele that may be attracted to these online interventions.

In conclusion, this review shows that, in general, psychological interventions offered completely online for alcohol and drugs do not reinvent the underpinnings of self-administered interventions in regards to both the theoretical approach and their content. The online format represents an alternative way to offer these interventions, which could increase accessibility and attract a clientele who would not consult otherwise. These

interventions appear promising and have short-term benefits among their users. However, further research is essential. Firstly, it is primordial to evaluate the efficacy of these interventions while including long-term follow-up measures. Secondly, the interventions offered through mobile applications appear to represent a challenge; they are based on less conventional approaches in regards to addiction and show mitigated results. This type of intervention should be further examined in order to ensure their safety. As such, other rigorous scientific studies are needed to be conducted before integrating them into a treatment program. Finally, development and evaluation of interventions that are entirely online for problem gambling are necessary steps to the diversification of intervention tools for this clientele.

AUTHOR CONTRIBUTIONS

Manuscript was written by IG, AG, JM, CJ, and SB. JM and SB helped with the study design, methodological issues and manuscript revision. Data were collected by AG and JM. The study and the manuscript redaction were supervised by IG. All authors made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; All authors worked on drafting the work or revising it critically for important intellectual content; and all authors approved the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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