PSYCHOLOGICAL MODELS FOR PERSONALIZED HUMAN-COMPUTER INTERACTION (HCI)

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PSYCHOLOGICAL MODELS FOR PERSONALIZED HUMAN-COMPUTER INTERACTION (HCI)

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EDITORIAL
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Editorial: Psychological Models for Personalized Human-Computer Interaction (HCI)

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Keywords: personalization, user modeling, human computer interaction, psychological theories and models, user characteristic

Editorial on the Research Topic

Psychological Models for Personalized Human-Computer Interaction (HCI)

1. INTRODUCTION

The behavior of users in the digital world, such as online shopping or social media activity, is increasingly supported by personalized systems, such as recommender systems (Ricci et al., 2015) and personalized learning. Early work on personalized systems was mainly data-driven, based on behavioral data, such as ratings, likes, and purchases (e.g., Bell et al., 2007). Although these systems are useful for both users and service providers, the main downside is the limited interpretability and explainability of the data. Such limitations in both interpretability and explainability translate in using data without understanding the root-cause of behaviors. Recent work has thus started to adopt a more theory-driven approach by including psychological theories and models to improve personalized systems (see for an overview; Graus and Ferwerda, 2019). These systems take advantage of psychological theories/models, such as emotions (Tkalčič et al., 2013b; Tkalčič and Ferwerda, 2018), personality (Ferwerda et al., 2017; Wu et al., 2018), skills (Ferwerda and Graus, 2018), and culture (Schedl et al., 2017) to explain and predict behaviors of users. This allows for a deeper understanding of users' behavior, preferences, and needs, which in turn also lead to more generalizable results.

Moreover, digital behavior has also been used to infer user traits and characteristics. For example, social media activities have been used to predict personality traits (Skowron et al., 2016) and intelligence, whereas the field of affective computing has been active in devising methodologies for inferring emotional states from digital signals (Tkalčič et al., 2013a).

2. RESEARCH TOPIC CONTENT

In view of this situation, this Research Topic aimed at collecting state-of-the-art research that supports personalized services with psychological theories/models. In particular, we encouraged the authors to submit original research articles, case studies, reviews, theoretical and critical perspectives, and viewpoint articles on the following topics: (i) *Psychological theories/models that explain online behavior* (e.g., personality, emotions, cognitive biases and illusions, learning styles, emotional contagion in group settings), (ii) *Psychological theories/models to personalize digital interactions* (e.g., in user interfaces, recommendations, social robots and chat-bots, e-learning), and (iii) *Prediction of psychological models drawing data from digital behavior information resources* (e.g., social media, e-commerce, physical activities, online learning, group scenarios).

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Within this collection we accepted 13 works. In total there were 11 original research articles, one brief research report and one perspective article. The authors affiliation countries were diverse, including Europe (Germany, Italy, Poland, Austria, Norway, and Sweden), North America (USA and Canada), and Asia (Pakistan, Japan, Malaysia, China, and South Korea).

The topics cover (i) *user characteristics* [technology acceptance (Pan), attachment styles (Sessa et al.), cognitive styles (Steichen and Fu; Schürmann and Beckerle), jealousy (Nordmo et al.), psychopatology (Sorokowski et al.), motivation (Huifeng and Ha; Hulaj et al.), needs (Hulaj et al.), personality (Xu and Ye; Abbasi et al.), and emotion (Cecconi et al.)], (ii) *inference* [from eye gaze (Steichen and Fu) and from social media (Cecconi et al.)], and (iii) *personalization* [survey (Neumayr and Augstein) and human-agent interaction (Schürmann and Beckerle)] in a (iv) *wide range of scenarios* [learning (Pan), communication (Sessa et al.; Miyamoto et al.), information visualization (Steichen and Fu), human-robot interaction (Nordmo et al.; Schürmann and Beckerle), consumer termination (Huifeng and Ha), video games (Hulaj et al.; Abbasi et al.), live streaming (Xu and Ye), and social media (Cecconi et al.)].

In this work, Pan explores how technology acceptance and self-efficacy contribute to the attitude toward technology-based self-directed learning. His results indicate a high relationship between these factors.

Sessa et al. explore how the attachment style influences the reaction in case of displeasing messages. Their results indicate that the communication styles of frankness and mitigation are related to attachment styles.

The psychological acceptability of utterances has been shown to be influenced by the social distance in the study conducted by Miyamoto et al..

The study conducted by Abbasi et al. was researching the relationship between personality and video games engagement. The results they obtained suggest that openness to experience, extraversion, agreeableness, and conscientiousness positively predict consumer engagement in electronic sports games.

Xu and Ye aimed at understanding the personality traits and the motivations of active live streaming viewers as well as their user behaviors in the general population in China. Their results indicate that extraversion was negatively associated with live streaming use, while openness was positively associated.

The emotion of Schadenfreude, pleasure at another's misfortune, has been investigated by Cecconi et al. , who found that, in an corpus of social media posts in italian, a set of hashtags (e.g., #Glistabene, #Benglista = hedeservedit) are strong predictors of shadenfreude.

Schürmann and Beckerle propose a framework for designing cognitive models for a given research question. The framework consists of five external and internal aspects related to the modeling process: research question, level of analysis, modeling paradigms, computational properties, and iterative model development.

Steichen and Fu found that a user's cognitive style can be inferred from the user's eye gaze while using an information visualization system.

Neumayr and Augstein present a systematic survey of personalized collaborative systems.

Nordmo et al. investigated the intimate relationship between humans and robots. They found that females expect to feel more jealousy if their partner got a sex robot, rather than a platonic love robot.

Hulaj et al. carried out a study investigating factors that influence dthe performance in video games in terms of matchmakin rating (MMR). They found that the perceived competence and autonomy were the only significant predictors of MMR performance beyond matches played.

Huifeng and Ha investigated what influences the termination of a customer relationship and found several factors: upkeep, time, benefits, personal loss, and motivation.

A research on the relationship between psychopatological personal traits and online hate behavior was conducted by Sorokowski et al. . Their results show that high scores in Psychopathy subscale are significant predictors of posting hating comments online.

AUTHOR CONTRIBUTIONS

BF, LC, and MT wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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ORIGINAL RESEARCH
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Friends, Lovers or Nothing: Men and Women Differ in Their Perceptions of Sex Robots and Platonic Love Robots

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Physical and emotional intimacy between humans and robots may become commonplace over the next decades, as technology improves at a rapid rate. This development provides new questions pertaining to how people perceive robots designed for different kinds of intimacy, both as companions and potentially as competitors. We performed a randomized experiment where participants read of either a robot that could only perform sexual acts, or only engage in non-sexual platonic love relationships. The results of the current study show that females have less positive views of robots, and especially of sex robots, compared to men. Contrary to the expectation rooted in evolutionary psychology, females expected to feel more jealousy if their partner got a sex robot, rather than a platonic love robot. The results further suggests that people project their own feelings about robots onto their partner, erroneously expecting their partner to react as they would to the thought of ones' partner having a robot.

Keywords: robot, relationships, jealousy, gender differences, companionship, sex, artificial intelligence

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INTRODUCTION

Advances in robot and artificial intelligence (AI) technology are moving at a rapid rate (Shoham et al., 2018). A number of scientists have predicted that robots will become an ordinary part of everyday social life, offering personalized service and companionship of different kinds (Schermerhorn et al., 2008; Flandorfer, 2012; de Graaf and Ben Allouch, 2013). Increasing sophistications of social AI such as Siri and Google Home invites the possibility of non-physical companionship between non-physical robots and humans. Companionship robots offer a promising avenue of innovation and research in fields such as child care, elderly care and certain branches of psychiatric care (Druin et al., 2000; Dautenhahn et al., 2006). One of the most fruitful promises of developing companionship robots is the alleviation of loneliness, which is especially prevalent among teenagers and the elderly (Victor and Yang, 2012) and has a detrimental effect on both physical and psychological wellbeing (Beutel et al., 2017).

As with many pioneering technologies before, applications of this technological advancement may be used to service both socio-emotional and sexual needs (Levy, 2007). Manufacturers intend to equip the more advanced sex robots with expanded options of movement and ability to converse appropriately with their owners. In the likely event that robots designed to satisfy human sexuality

and emotion are commercialized, ethical, psychological, and social issues regarding human-robot interaction will emerge (Sullins, 2012; Richardson, 2016; Scheutz and Arnold, 2016; Danaher and McArthur, 2017; Frank and Nyholm, 2017). On a positive note, sex robots offer the promise of limiting or ending prostitution, sex-tourism and human trafficking associated with sex work (Yeoman and Mars, 2012). However, differences in psychological and moral perceptions of the use of sex robots may hamper market penetration. The field of research on perceptions of social robots is understandably limited, but the research holds some promise in both understanding how we view robot interaction. Contrasting findings on attitudes and psychological reactions to robot-human interaction may be informative to understand questions regarding general social topics as well. Based on earlier research (Nomura et al., 2006a), that showed a gender difference in attitudes toward robots, we posit that men and women will react differently to the prospect of robot human interaction. Scheutz and Arnold (2016) report the results from a survey of people's attitudes toward sex robots. They found consistent evidence for a gender difference in how interested the respondents were in the prospect of sex robots, with men considering them more useful than women. While the results from this survey informed the basic premise of our study, we investigate the topic further by running a controlled survey experiment in which we vary the type of robot the participants read about. We therefore attempt to add to the literature by proposing the research question: How do men and women differ when evaluating the use of a platonic love robot or a sex-robot? In this research, we were interested in exploring gender differences in attitudes and predicted emotional reaction to two different kinds of social robots: (1) An AI sexual robot which can exclusively service physical sexual needs, and (2) an AI platonic love robot without a humanoid physical form which can form an intimate emotional bond with its owner, but are unable to engage in any sexual interactions in any form. Several factors motivated the direction of our exploration. Firstly, while a vast literature has amassed in psychology and sociology, describing gender differences in sexuality and social preferences, this literature has yet to be fully extended into the setting of human-robot interaction (Schermerhorn et al., 2008). Psychology offers a perspective on the perception and adoption of technology that is not always considered in technical circles. Understanding how users respond to robots and the reasons behind their responses will enable designers to create robots that fit well with the social, moral and relational climate they are targeting (Young et al., 2008). Understanding the role of gender differences in the perception of companionship robots and sex robots is not only necessary in order to tailor product development to different market segments, - it also offers a new and potentially fruitful avenue for understanding gender differences in basic needs and desires.

Theory and Hypotheses

The overall aim of this exploratory study is to describe how men and women react to the possibility of robots designed exclusively for sex or love, and how they envision their partners' reaction. Because these robots are not commercially available we designed the study to measure the predicted attitudes when imagining themselves and their partner interacting with it. Our study thus continues the exploration performed by Scheutz and Arnold (2016), in their survey of people's attitudes toward sex-robots. In their survey, Scheutz and Arnold uncover a gender difference in how interested men and women are in sex robots, and how useful they are. However, the authors find evidence of gender convergence on the question of how interaction with a sex robot is to be classified and generally thought about. On this basis, Scheutz and Arnold suggest that larger views about robots, relationships and society, not just understandings of the robots themselves, should be a matter for more research. Our study represents an extension of this work, as it delves into the topic of how different types of robots with different capabilities are perceived and evaluated by men and women, using an experimental study design. We also add to the insights provided by Scheutz and Arnold (2016) by exploring peoples assumptions about their real or hypothetical partners reactions to the eventuality of them acquiring and using different kinds of robots.

Past research into gender differences in attitudes toward robots is limited. Nomura et al. (2006a) presented evidence suggested that in general, males were more positive toward interacting with the social robot; *Robovie* (Ishiguro et al., 2003). The present study represents a continuation of the findings provided by Nomura et al. (2006a), that showed a gender difference in attitudes toward robots. Based on their findings, we predicted that females would show greater general overall dislike to the thought of a robot, and find the thought of interacting with a humanoid robot less appealing. We therefore formulated our first hypothesis:

> *H1) Males will have more positive attitudes toward robots, compared to the attitudes held by females.*

The experiment reported by Nomura and Kanda (2003) revolved around attitudes to a non-sexual, social robot. We wanted to explore gender differences toward robots designed to engage in different kinds of intimacy. In doing this, we wanted to bridge together insights from basic research on emotional intimacy and sexual preferences with novel questions arising from the advent of artificially intelligent robots. Previous research has documented predictable gender differences in preferences for emotional intimacy and sex (Buss et al., 1992; Petersen and Hyde, 2010). A key finding from this research is that men consistently have more frequent and more intense sexual desires than women do. This difference in sex drive is reflected in the reported prevalence of spontaneous thoughts about sex, frequency and variety of sexual fantasies, desired frequency of intercourse, desired number of partners, masturbation, pornography-use, attitudes toward casual sex, liking for various sexual practices, willingness to forego sex, initiating versus refusing sex, and making sacrifices for sex (Baumeister et al., 2001). In their 2016 survey, Scheutz and Arnold found evidence of a consistent difference between men and women in how useful and attractive the idea of a sex robot is. As the advent of sex robots has the potential to satisfice many sexual desires that otherwise would

remain unfulfilled, it is reasonable to expect that males will continue to have more favorable attitudes toward sex robots.

Furthermore, we wanted to bridge the understanding of gender differences in preferences for platonic social and emotional intimacy to the prospect of platonic love robots. The idea of gender differences influencing the adoption of new technologies is not new. The history of technological product development already contain examples of how the adoption of products was affected by gender differences in social preferences. For instance, while the telephone was initially marketed as a professional tool reserved for male-dominated spheres, it was essentially appropriated by females to serve social ends (Fischer, 1988). Examples like these underline the importance in understanding gender differences when predicting the adoption of new products. Several strands of evidence from psychological research have suggested systematic gender differences in preferences for platonic emotional intimacy. Firstly, meta-analytic research on personality traits have found that females score higher than males on traits relating to a stronger social preference, such as extraversion, anxiety, trust, and, especially, tender-mindedness (i.e., nurturance) (Feingold, 1994). Females report having stronger and more rewarding friendships, especially with other females (Wright and Scanlon, 1991). Males score higher on self-compassion than females, which may provide some explanation for the gender difference in preference for social intimacy (Yarnell et al., 2015). Behavioral data also indicate gender differences in social needs and desires. Females self-disclose more than males, especially when talking to a person they have an established relationship with (Dindia and Allen, 1992). Females are also more inclined to seek emotional support from others as a way of coping with difficult emotions and general difficulties in life (Tamres et al., 2002; Nolen-Hoeksema, 2012). By contrast, men display a more avoidant adult attachment style, especially in intimate romantic attachment (Del Giudice, 2011). Research across multiple economic experiments demonstrate that females have a more other-regarding social preference (Croson and Gneezy, 2009). Meta-analytic findings from professional settings also provide support for the notion of gender differences in social preferences. Females have a more cooperative style of negotiating (Walters et al., 1998), a more democratic or participative style of leading (Eagly and Johnson, 1990), provide more psychosocial support as mentors (O'Brien et al., 2010), and endorse compromise more often as a conflict resolution strategy (Holt and DeVore, 2005). Research on attitudes toward seeking help in clinical settings can also provide direction to our second hypothesis, as meta-analytic suggests that females are more positive toward seeking professional help to alleviate psychological distress (Nam et al., 2010). Taken together, these findings provide plausible evidence for a slightly stronger preference for platonic social intimacy among females, compared to males, and a slightly stronger preference for pure sexual relationships among males, compared to females. On this basis, we formed our second hypothesis:

> *H2) Males will be more positive toward sex robots than platonic love robots, while females will be more positive toward platonic love robots than sex robots.*

Both social robots and sex robots may appeal to males and females who live alone, or without a partner. Moreover, if these robots are to gain broad market appeal, they also need to be embraced by people living in committed relationships. Although men and women in committed relationships may not have the same social or sexual needs as individuals in relationships, they may still want to explore a social or sexual relationship with a robot. Loneliness and objective social isolation are often weakly correlated (Coyle and Dugan, 2012; Holt-Lunstad et al., 2015) and many people who have a partner report experiencing loneliness and sexual frustrations. Similarly, pornography use is widespread among heterosexual males in committed monogamous relationships, and many men who solicit prostitutes are married, which suggests that some sexual desires are not met by the sexual activities in the relationship (Sanders, 2013; Maas et al., 2018). By all accounts therefore, it is possible that both males and females in committed relationships may come to harbor a desire to include a sex robot or a social robot in their daily life as committed partners. Actual demand, however, will be very much contingent on how the partner feels about the presence of the robot. We therefore also explored how males and females would feel about their partner acquiring and using a social robot or sex robot. Psychological research has a rich tradition for exploring gender differences in jealousy, defined as negative feeling or suspicion that one's partner is attracted to or involved with someone else (Buss et al., 1992). The general finding from evolutionary psychology suggests a slight difference between males and females in propensity to experience jealousy in different situations. Males tend to feel more jealousy when thinking about or experiencing their partners sexual infidelity, as compared to emotional/romantic but non-sexual infidelity. Females show the opposite pattern. On this basis we formed our third hypothesis:

> *H3) Males will expect to feel more jealous if their female partner gets a sex robot, while females will expect to feel more jealous if their male partner gets a platonic love robot.*

Although several knowledgeable experts have claimed that artificially intelligent robots will be developed in the near future (Levy, 2007), and despite the popular appeal of fiction television series and movies that portray such a future, it can be difficult for research participants to envision and predict specific emotional reactions to these scenarios. It may also be that research participants are able to predict their general emotional valence (positive/negative) to the prospect of their partner having a robot, but that they disagree with labeling the negative emotion jealousy. In order to partially circumvent this validity threat, we also explored how participants felt in general about the prospect of their partner having a robot. We also explored how the participants theorized that their partner would react to them having a robot. This latter measure is presumably important for the market success of the robots; if one expect that one's partner would hate the idea of a robot, then one would presumably never even entertain the topic and explore the accuracy of those expectations. Our theoretical predictions of general liking and disliking of one's partner having a robot was rooted in the same

evolutionary psychological account that formed the basis for the predicted gender differences in jealousy. As such, we expected males to dislike the idea of their female partner having a sex robot more than they would dislike her having a social robot. For female participants, we expected the opposite pattern. Our fourth hypothesis was thus:

> *H4) Males will be more negative to the prospect of their female partner getting a sex robot, while females will be more negative to the prospect of their male partner getting a platonic love robot.*

Lastly, we wanted to explore differences in expectations about how their partner would feel if they decided to have a robot. This issue is of importance, as many people in committed relationships presumably will avoid purchasing a robot that they expect their partner will dislike them having. Their theories about their partners feelings will thus guide their behavior. When people theorize about the preferences of others, in settings where they don't have good information to guide their theorizing, they tend to project their own feelings and goal states to the other person (Newman et al., 1997; Maner et al., 2005). Especially when particular emotions and goals are activated and made salient, people tend to over-perceive similar emotions and goals in others (Niedenthal et al., 2000; Kawada et al., 2004). As our participants presumably did not have accurate and updated information about how their partner would feel about them getting a robot, we expected that participants would theorize that their partners feelings about them having a robot would mirror their own. We thus postulated our fifth and final hypothesis:

> *H5) Males will expect that a partner would respond more negatively to him having a platonic love robot, while females will expect that a partner would respond more negatively to her having a sex robot.*

MATERIALS AND METHODS

Participants

We performed a vignette experiment with 163 female and 114 male participants. Recruitment of participants was accomplished by online distribution of the study. Mainly, we published the study on social media and distributed it by e-mail. The participants' age varied from 17 to 70 years with a mean of 27.29 (SD = 9.8) years. The majority (68%) of the respondents were students. Most participants were heterosexual (90%), a few participants were homosexual (2%) and some did not identify as either sexuality (8%). Participation was voluntary and anonymous.

Design

The experiment included two conditions to which the participants were randomly assigned; one in which they were exposed to a vignette about a futuristic sex robot, and in the other condition to a vignette about a love robot with advances social and emotional competencies, but without a humanoid physical form or ability to engage in sexual interaction. We purposefully described the robots as being either exclusively for sexual use, or exclusively for platonic love. The vignettes were presented with associated visual stimuli; a sexualized photo of an artificial looking man and a woman (sex robot) and a photo of ear plugs (platonic love robot). Extracts of the vignettes are available down below, while full versions and photos are presented in the **Appendix**.

Sex Robot

Imagine the year 2035. The world has seen great advances in artificial intelligence and robotics. One of the advances has led to the development of highly realistic sex robots, both in male and female form. The robots looks and feels just like humans (.). The artificial intelligence the robots are equipped with enables them to learn their owner's sexual preferences through experience (.). User surveys show that the owners of this kind of sex robot are extremely satisfied (.). Even though the sex robots are equipped with a highly sophisticated artificial intelligence, there are some limitations to them. The robots can only have a sexual relationship with their owner. Attempts of non-sexual interactions will either be misunderstood, ignored or interpreted in a sexual way by the robot (.). The robots cannot form a meaningful romantic or friendly relation with a human.

Platonic Love Robot

Imagine the year 2035. The world has seen great advances in artificial intelligence and robotics. One of the advances has led to the development of highly realistic love robots, both in male and female form. The robots able to talk to their owners in a way that feels very human-like and realistic (.). The artificial intelligence the robots are equipped with enables them to get to know their owner through experience (.). User surveys show that the owners of this kind of love robot are extremely satisfied (.). Even though the love robots are equipped with a highly sophisticated artificial intelligence, there are some limitations to them. The robots have no physical body, it only exist in a small microphone and speaker (.). It can form a meaningful romantic and friendly relation to a human, but it cannot satisfy the owner in a sexual manner.

Measurements

After reading about either the love robot or the sex robot, the participants were asked to think of a committed romantic relationship they have had at a previous time, are engaged in now or wish to have in the future. They were then asked to fill out a questionnaire regarding how they imagine themselves reacting if their partner owned and used a robot similar to the one they had read about, and how they think their partner would react if themselves interacted with such a robot on a regular basis. All items were recorded on a seven point scale from: (1) *Totally agree* to (7) *Totally disagree* as well as (4) *neither agree nor disagree*. All items were presented in Norwegian and were translated to English using a translation process in accordance with the recommendations made by Douglas and Craig (2007).

Robot Attitudes

Attitudes toward robots were measure with three items; *I hope this type of robot is developed in the future. I look forward to the*

development and launch of this type of robot. I feel we should not develop this type of robot (reversed). Cronbach's alfa for the measure was 0.94.

Jealousy

Robot jealousy was measured with the three items; *This kind of robot would evoke strong feelings of jealousy in me. I think I would feel jealous of this robot. I will not become jealous of this robot* (reversed). Cronbach's alfa for the measure was 0.92.

Dislike of Partner's Use

Dislike of a partner's use was measured with three items; *I alone should take care of this kind of needs for my partner. I would like my partner to get rid of this robot. I do not mind my partner using this robot* (reversed). Cronbach's alfa for the measure was 0.90

Predicted Partner's Dislike of Own Use

How individuals predict their partner's reaction to their own use of a robot was measures with three items: *My partner would not like it if I used this type of robot. My partner would want me to get rid of the robot. I think my partner would like me using this robot* (reversed). Cronbach's alfa for the measure was 0.90.

Belief in Robot Technology

We also measured to what extent the participants in the experiment believe this kind of robot will be developed in the future, with three items; *I think we will see such robots developed in the future. Robots like these are going to be on the marked soon. We will never see this type of robot in production* (reversed). Cronbach's alfa for the measure was 0.92.

Control Question

The participants also answered a control questions after being presented with the experimental stimulus, before the questionnaire. Participants were asked the control question (*The robot I read about can only engage in sexual relations*, (1) Correct, (2) Incorrect, (3) I do not remember). Wrong answers and admission of not remembering led to removal from the dataset.

Demographics

Lastly, the participants recorded age, gender, sexual orientation and student status (y/n). The survey was estimated to take 5-7 min to complete. The participants received no reward or compensation for participating.

Statistical Analysis

Due to differences in number of male and female participants, we testes the assumption of equal variance between genders in preliminary analysis with Levene's test and found no unequal variances in the four outcome variables. We analyzed the experiment data with full factorial regression analysis. Two models were tested for each of the four outcome variables: Belief in robot technology and age constitutes validation variables, while main effects and the interaction between gender and experimental condition investigate the research questions. We used marginal estimates to graphically plot the interaction effect. Differences between predicted estimated values are tested with *F*-tests. We also present descriptive information and pairwise correlations between the studies variables. Alfa was set to 0.05.

RESULTS

The high mean of belief in robot technology show that most of the participants believe that robots designed for intimacy are realistic, both in sex robot and platonic love robot format. This provides some support for the validity of the study. In line with past research on the topic, the general attitudes toward the robots were negative, regardless of the gender of the participants and type of robot. Attitudes toward the robot were positively correlated with a belief in robot technology and negatively correlated with dislike of their use, predicted level of partners dislike, as well as jealousy. We did not find any significant correlations between age and the robot attitudes and belief in robot technology. The descriptive statistics and pairwise correlations are all presented in **Table 1**.

Hypothesis Testing

The results from the main effect and interaction effect models are presented in **Table 2**. Hypothesis 1 stated that males will have more positive attitudes toward robots, compared to the attitudes held by females. In support of this we found a significant negative main effect of gender on attitudes toward robots [$B = -2.97$, $p < 0.01$]. This finding demonstrates that males are more positive toward robots than females, regardless of experimental condition and type of robot they envision. In addition to attitude, the results also showed a negative main effect of gender on both dislike if their partner had a robot [$B = 1.51$, $p < 0.01$], and jealousy [$B = 1.59$, $p < 0.05$].

TABLE 1 | Descriptive Statistics and pairwise correlations.

Variables	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Robot attitudes	10.19	4.73	1.00							
(2) Belief in robot technology	17.16	3.31	0.29**	1.00						
(3) Dislike partners use	17.56	3.66	−0.45**	−0.05	1.00					
(4) Predicted partners dislike	17.19	3.59	−0.28**	0.08	0.55**	1.00				
(5) Jealousy	14.80	4.81	−0.20**	0.05	0.58**	0.29**	1.00			
(6) Gender	1.63	0.48	−0.34**	−0.18**	0.20**	−0.08	0.13*	1.00		
(7) Experimental condition	1.50	0.50	−0.06	0.04	0.07	0.19**	0.08	−0.04	1.00	
(8) Age	27.29	9.80	0.05	−0.10	−0.08	−0.004	−0.08	−0.21**	0.04	1.00

*$p > 0.05$ **$p > 0.01$

TABLE 2 | Main and interaction effects of gender, experimental condition, with age and belief in robot technology as control variables.

	Jealousy		Robot attitudes		Dislike partners use		Predicted partners dislike	
	Main effect	**Interaction**	**Main effect**	**Interaction**	**Main effect**	**Interaction**	**Main effect**	**Interaction**
Intercept	9.50** (2.47)	12.71** (2.03)	10.54** (2.28)	5.38** (2.92)	14.88** (1.93)	17.77** (1.58)	15.06** (1.85)	16.72** (1.51)
Age	−0.01 (0.03)	−0.01 (0.03)	0.005 (0.02)	0.005 (0.17)	−0.01 (0.02)	−0.01 (0.02)	−0.008 (0.02)	−0.007 (0.02)
Belief in robot technology	0.11 (0.08)	0.11 (0.08)	0.33** (0.08)	0.33** (0.08)	−0.024 (0.06)	−0.025 (0.06)	0.06 (0.06)	0.062 (0.06)
Gender	1.59 (0.62)*	0.58 (0.86)	−2.97** (0.57)	−1.09 (0.57)	1.51** (0.48)	0.514 (0.67)	−0.49 (0.46)	−1.66** (0.63)
Experimental condition	0.98 (0.57)	−0.28 (0.95)	−0.92 (0.53)	1.45 (0.54)	0.74 (0.45)	−0.511 (0.73)	1.39** (0.43)	−0.085 (0.70)
Gender*Condition		1.99 (1.19)		−3.79** (0.52)		1.98* (0.93)		2.35** (1.51)
Adjusted R^2	0.02	0.03	0.16	0.20	0.04	0.05	0.03	0.05

*Males and platonic love robots are reference groups for gender and experimental condition. SD in parenthesis. N = 163 women and 114 men. * p < 0.05; ** p < 0.01*

Hypothesis 2 stated that male participants would be more positive toward robots if they had read a description of a sex robot, while female participants would be more positive toward robots if they had read a description of a platonic love robot. The results showed a significant negative interaction between gender and experimental condition confirming this hypothesis [$B = -3.79$, $p < 0.01$]. As seen in **Figure 1**, the interaction on attitudes between type of robot and gender was due mostly to the female participants disliking the sex robot, compared to the platonic love robot [$F(1, 257) = 12.66$, $p < 0.01$]. Males were more positive toward sex robots than platonic love robots, but not to a statistically significant degree. All in all the results suggest that males and females have very similar attitudes toward platonic love robots, but differ substantially in their attitudes toward sex robots, in that males are somewhat positive and females very negative to them.

Hypothesis 3 stated that males will expect to fell more jealous if their partner got a sex robot, while females would expect to feel more jealous if their partner got a platonic love robot. The results failed to provide support for this hypothesis. As mentioned, males expected to feel less jealous than females, regardless of type of robot their partner acquired. However, contrary to our expectations, the females expected to feel significantly more jealous if their partner acquired a sex robot, compared to females who envisioned that their partner acquired a platonic love robot [$F(1, 257) = 5.57$, $p < 0.05$].

Hypothesis 4 stated that that females would dislike the thought of their partner having a platonic love robot more, while males would dislike their partner having a sex robot. The results from the interaction model confirmed this hypothesis [$B = 1.98$, $p < 0.05$]. As seen in **Figure 1**, the small positive interaction effect is primarily due to the difference in predicted dislike at the thought of their partners use of the sex robot compared with a platonic love robot [$F(1, 257) = 6.80$, $p < 0.01$]. Male participants reported statistically similar levels of predicted dislike, regardless of what type of robot they had read about.

The fifth and final hypothesis suggested that males would expect their partner to dislike it more if he acquired a platonic love robot, while females would demonstrate the opposite pattern. This expectation was founded on the idea that the participants would project their own feelings onto their partners. The results provided support for such a projection account and showed a significant positive interaction effect [$B = 2.35$, $p < 0.01$]. Also seen in **Figure 1**, female participants expected their partners to dislike her having a sex robot, but be more comfortable with her having a platonic love robot [$F(1, 257) = 17.81$, $p < 0.01$]. By contrast, male participants expected their partners to be equally negative to him having either kind of robot.

DISCUSSION

The results of the analysis confirms previous findings that males are more positive toward the advent of robots than females (Scheutz and Arnold, 2016). Females who had read about the sex robot reported particularly elevated levels of jealousy, less

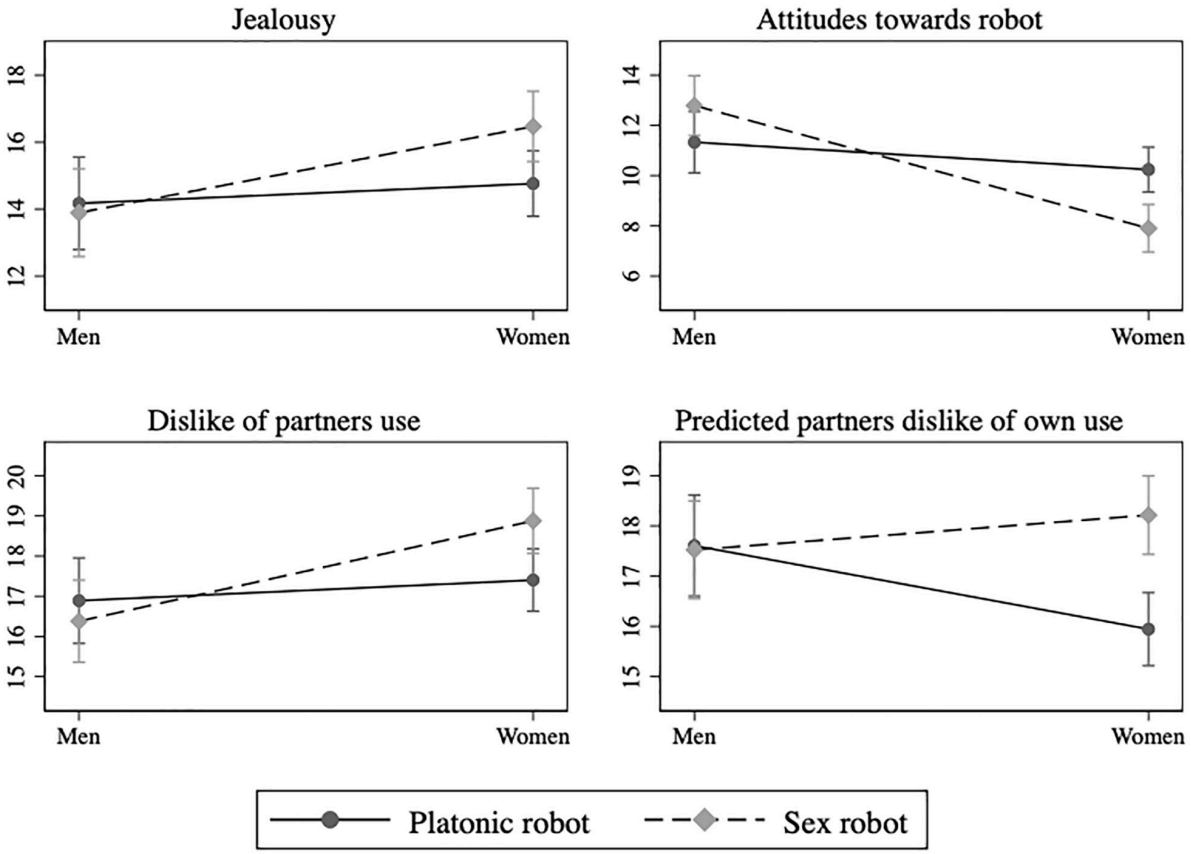

FIGURE 1 | Interaction effects of gender and experimental condition on dependent variables.

favorable attitudes, more dislike and more predicted partner's dislike. This pattern was not found in the male sample, whose feelings were largely unaffected by the type of robot they were made to envision.

One possible explanation for the gender difference could be a combination of differences in how males and females frame the concept of human-robot sexual relations, as well as different attitudes toward masturbation and the use of artificial stimulants for masturbatory purposes. Past research has indicated that males masturbate more, have more permissible attitudes toward masturbation, use more pornography, and have more permissive views of pornography consumption (Baumeister et al., 2001; Petersen and Hyde, 2010; Regnerus et al., 2016; Maas et al., 2018). If the males in the present study framed the prospect of having sex with robots as allegorically to masturbation with pornography, while the females considered the act more allegorical to cheating, one would expect the present results to emerge. While we did not include measures of how the participants view sex with robots, past research has suggested that males tend to think of sex with robots as a form of masturbation, not sex (Scheutz and Arnold, 2016). The overall gender difference in attitudes may also be partly due to men expressing their positive views more readily, while women may explicitly or implicitly not want positive attitudes toward robots. Future research should explore the moral and relational framing of human-robot sex in depth, including potential gender differences therein.

A different explanation for the observed results is that sex dolls and sex robots to this day primarily have been marketed toward men (Danaher and McArthur, 2017). This can explain why this idea evokes stronger negative feelings among females. In addition, the men and women might react differently to the lack of strong social cues in the sex-robot. According to the Persuasive robot's acceptance model (Shazwani binti Ghazali, 2019), social cues and a lack of social cues predict attitudes toward robots. Women may view the sex robot in a more negative way both because they do not observe social cues and do not have an immediate sexual response. The observed gender differences may also be partly due to men and women finding it difficult to visualize forming a romantic bond with a non-human entity. Interestingly, studies have revealed that people seem to assume a more mutual relationship even with completely non-social service robots like vacuum cleaners (Forlizzi and DiSalvo, 2006; Sung et al., 2007). Such findings suggest that people get deeply engaged with robots even without humanoid qualities. However, the current study suggest that this effect may only be present in true interaction, not when anticipating future interaction, as our results indicate relatively small effects.

Findings from evolutionary psychology has generally indicated that females experience more jealousy at the thought of their partner having a romantic bond with another person, while males experience more jealousy at the thought of their female partner having a sexual relationship with another man (Buss et al., 1992, 1996, 1999). This finding has been explained by the different evolutionary imperatives faced by males and females. In a pre-industrial state, males had to compete for reproductive resources, and could know for certain whether the offspring they provide valuable resources to were actually related to them. Males have therefore developed their feelings of jealousy as an adaptive strategy to motivate behaviors that reduce paternity uncertainty and loss of access to reproductive resources. Their jealousy is thus especially attuned to the threat of sexual encounters. Females, on the other hand, faced certainty in their rightful motherhood, but face the risk of their partner abandoning her and their common offspring, which severely compromises the odds of survival. Their jealousy is thus geared less toward purely sexual escapades without any other forms of attachment, and more concerned with emotional bonds that may distract paternal investment in partner and offspring. This adaptation account has been proposed as a the explanation for the observed gender differences across cultures (Buss and Haselton, 2005). One problem facing this account is that it can be difficult for participants to envision their partner in a purely emotional or purely sexual relationship with someone, without envisioning that the relationship can change and evolve over time. A purely romantic attraction can evolve into a sexual one, and vice versa. In this study, however, we offer a more "clean" manipulation of this variable, in that the robots we described were either purely sexual or purely non-sexual. The sex robot was explicitly described as unable to engage in anything more than a sexual relationship, while the platonic love robot was explicitly described as disembodied and unable to satisfy physical sexual urges. Our findings therefore shed new light on how males and females feel about different kinds of infidelity in a setting where sex cannot lead to love and love cannot lead to sex.

Our results further show that males and females varied in how they expected to feel if their partner acquired and used a sex robot or platonic love robot. However, the results demonstrate that both males and females fail to predict how their partner would feel if they themselves got a robot. Males, who report feeling at ease with the thought of their partner having a robot, erroneously expect that their partners will extend the same relaxed attitude toward them. Females on the other hand, who are negative to the prospect of their male partners having a sex robot, and neutral to them having a platonic love robot, erroneously expect their partners to react negatively to them having a sex robot and positively to them having a platonic love robot. These results are in line with a projection account, which suggests that people tend to expect their partners to feel as they would have, especially in emotionally charged situations (Newman et al., 1997; Kawada et al., 2004; Maner et al., 2005).

Limitations

There are two notable limitations to the present study. The first is the recruitment procedure and sample. Participants were recruited primarily via social media (Facebook) and accessible e-mail lists to workplaces. Therefore, our sample is likely to be influenced by a self-selection bias, whereby those who thought human-robotic interaction more interesting presumably were more likely to participate in the study. The sample of participants consisted of a majority of students, and was somewhat restricted in age variation, which limits the generalizability of the findings. In addition, the results cannot be directly generalized to homosexual populations as the sample was almost exclusively heterosexual. The second limitation is the use of novel non-validated measurements. There are few validated measurements of reactions to robots, and to the best of our knowledge, none that capture sentiments regarding sex and love robots. The *Negative Attitudes toward Robots Scale* (NARS) (Nomura et al., 2006b) is too general for the purposes of our study. In order to gain thorough understanding of how people feel about different types of robots designed for physical and emotional intimacy, improved measurement scales need to be designed and validated.

CONCLUSION

Physical and emotional intimacy with robots may become more commonplace over the next decades, as technology improves at a rapid rate. The results of the current study show that women have less positive views of robots, and especially of sex robots, compared to men. The results further suggests that people project their own feelings about robots onto their partner, erroneously expecting their partner to react as they would to the thought of ones' partner having a robot.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee at BI Norwegian Business School, Campus Bergen. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2020.00355/full#supplementary-material

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Are Online Haters Psychopaths? Psychological Predictors of Online Hating Behavior

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Despite growing prevalence of derogatory online behaviors, still little is known about psychological factors underlying this negative phenomenon. In the present study, we aimed to compare characteristics of persons who post hating and non-hating comments about Polish sports players during Winter Olympic Games in Pyeongchang (2018) on the Internet. Ninety-four Internet users (41% women) participated in the study, among which 46 posted hating comments. After 1 month, participants were invited to take part in a psychological survey, and filled the Dark Triad questionnaire, the Satisfaction with Life Scale, the Scale of Frustration, and the Scale of Envy. Results showed that high scores in Psychopathy subscale were significant predictors of posting hating comments online; high scores on the Envy Scale were marginally significant. Our findings provide initial evidence that persons who engage in derogatory online behavior have a high level of Psychopathy, but, contrary to previous studies, do not have elevated levels of other traits, commonly associated with disruptive behavior. Our research is one of the first to establish a psychological background of online haters, while setting a clear line between online hating and other derogatory online behaviors (e.g., trolling, cyber-bullying, or hatred speech).

Keywords: online haters, online hating, hate speech, Psychopathy, Dark Triad

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INTRODUCTION

Derogatory behavior has been long identified as a major social problem. It is not surprising that along with the growth of Internet popularity, such behaviors have been also observed in online settings (Blaya, 2019; Gauducheau, 2019; Johnson et al., 2019; Mathew et al., 2019), and thus identified as online hatred. Online hatred has been shown to inflate negative emotions (Lange, 2007), cause suicides (Marcus, 2018), and even lead to the assassination of public figures (e.g., Nyczka, 2019). Internet hate may affect not only human lives but also non-human targets. For instance, hate campaigns have been proven to be responsible for failures of big-budget movies (Bay, 2018). It seems that the phenomenon of online hate behavior is becoming more and more prevalent (Gagliardone, 2019), and so is the scholars attention to tackle this issue (Blaya, 2019; Derzsy, 2019; Johnson et al., 2019).

Despite the growing literature on hate behavior (Blaya, 2019), little is known about the personal characteristics of people who routinely engage in such behavior. There is not even an unanimous scholars' agreement on what constitutes the definition of "Internet hating" or "haters," as those terms have been referred to a broad range of derogatory behaviors (Shepherd et al., 2015; Cook et al., 2018). Primarily, it is worth to highlight the distinction between online hating and other forms of negative online activities. For instance, the purpose of hate

speech is to express contempt and undermine the position of a given social group (according to e.g., race, gender, and nation) by expressing a disparaging opinion about that group, its particular members or its characteristic products (Nockleby, 2000). Thus, it is not considered hate speech to express a disparaging opinion about a person independently of their belonging to a given social group (Nockleby, 2000; Ortiz, 2019). Online hating, on the other hand, does not necessarily consists in expressing a disparaging opinion about a social group. It may be derogatory without in any way referring to the social position of a given person or object, and/or aiming at diminishing the social position of a group. Typical examples found on Facebook and other websites include comments that insult, for instance: public figures, sports person, actors (i.e., "*How can such a loser earn so much money!?*"; "*S/he must have got this job because s/he paid someone a lot or s/he has an "influential" uncle*"), deceased persons (i.e., "*This idiot drove so fast so s/he got what s/he deserved*"; "*What a stupid way to die, lol*"), or any other Internet users who post things online (i.e., active users of Facebook, YouTube, Instagram, Twitter, Twitch, and so on).

Scholars' attention has been devoted to Internet trolls (Buckels et al., 2014; March, 2019), cyber-bullies (Fearn, 2017), and those who express hate speech (i.e., statements that are explicitly aimed at a certain social group) (Ortiz, 2019), with the lack of emphasis put on the recognition of personal characteristic of online haters (who may hate on a person regardless of the victims' e.g., age, gender, or ethnic group). Each of those three derogatory online behaviors (i.e., trolling, cyber-bulling, and hate speech) have been connected with a slightly different psychological profile (Bishop, 2013, 2014). For instance, trolls have been told to score high on Psychopathy (while high scores on other Dark Tetrad characteristics have been inconsistently reported); and cyber-bullies have been told to score high only on sadism (for a review, see Moor and Anderson, 2019). Thus, it is reasonable to assume that those who routinely engage in online hating may exhibit certain, common characteristics, different on the type or severity from aforementioned behaviors. Nevertheless, to our knowledge, there is scarce data on the individual characteristics of online haters (who remain unidentified in previous research).

The main aim of the present study is to identify psychological predictors of posting hating comments online. Based on the initial literature review, we decided to focus on the following traits: Dark Triad (i.e., Narcissism, Psychopathy, and Machiavellianism), level of experienced frustration, level of experienced envy, and satisfaction with life. Dark Triad has been frequently used in previous studies on derogatory online behaviors (e.g., Golf-Papez and Veer, 2017; Sest and March, 2017; March, 2019; Moor and Anderson, 2019), and thus, examining Dark Triad traits should be the first step in establishing the commonalities and differences of online haters to other types of persons who exhibit negative behaviors online (e.g., trolls, cyber-bullies). A classic frustration-aggression hypothesis posits that frustration may lead to aggressive behaviors (Miller, 1941). More recently, Breuer and Elson (2017) overviewed numerous empirical research, and found evidence for the frustration-aggression link. Thus, it is reasonable to assume that if the frustration fosters aggressive behaviors, such occurrence may be even more pronounce in the online setup, as internet offers various ways to express verbal aggression (Wallace, 2015). Envy has been linked not only to one of the subscales of Dark Triad – Narcissism (Krizan and Johar, 2012), but also to indirect (verbal) aggression (Hofer and Busch, 2011), thus, we hypothesize that online haters may experience elevated levels of envy. Lastly, we expect that satisfaction with life could be negatively related to engaging in online hating, as being content with one's life may buffer against both negative feelings, and aggressive behaviors (Valois et al., 2006). We will also examine the role of gender, as it was previously reported to be a predictor of negative online behaviors (Buckels et al., 2014; Craker and March, 2016; Sest and March, 2017).

METHODS

Participants

Ninety-four Poles (41% women) aged 15–71 years (M = 33.4; SD = 13.9) participated in the study. Forty-six of them (further referred to as haters; 44% women, age M = 33.5; SD = 13.7) exhibited hating behavior (i.e., posted at least one comment, independently classified as online hating by two of the authors), and 48 persons (40% women, age M = 33.4; SD = 14.2) posted neutral comments (further referred to as non-haters; i.e., comments, independently classified as non-hating by two of the authors). Ethical approval of the study's protocol was provided by the ethics committee at the Institute of Psychology (University of Wrocław).

Procedure

Present study was conducted during Winter Olympic Games in Pyeongchang (2018). Authors searched for sports journals where performance of Polish Olympic Games contestants was reported and followed by comments through Facebook accounts. Online comments were independently screened and identified as hating or non-hating by two of the authors. Only if the agreement between authors was reached, the person who posted a given comment was identified either as an online hater or non-hater. We operationalized online hating posts as statements expressing a negative, insulting attitudes toward sports players; evaluative but not including constructive criticism. Exemplary

TABLE 1 | Descriptive statistics for analyzed variables with regard to the group (i.e., haters, N = 46 and non-haters, N = 48).

	Haters		Non-haters	
	M	**SD**	***M***	**SD**
Age	33.47	13.65	33.27	14.18
Frustration	2.93	1.57	2.10	0.66
Envy	3.39	1.34	2.64	0.72
Narcissism	2.40	1.18	2.17	1.18
Psychopathy	2.11	1.07	1.56	0.49
Machiavellianism	2.18	0.90	2.04	0.82
Satisfaction with life	3.62	1.03	4.16	1.00

TABLE 2 | Correlation matrix between psychological subscales for both groups (haters and non-haters) combined (Spearman's rho).

	Frustration	Envy	Narcissism	Psychopathy	Machiavellianism	Satisfaction with life
Frustration	–					
Envy	0.32**	–				
Narcissism	0.15	0.19	–			
Psychopathy	0.09	−0.05	0.06	–		
Machiavellianism	0.16	0.06	0.67***	0.14	–	
Satisfaction with life	−0.15	−0.19	0.16	−0.01	0.01	–

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

hating comments included: "*She discredits our country and does it for taxpayers' money, give me my money back!*," "*Representing our country while being so ugly should be banned*." Exemplary non-hating comments included positive statements: "*It's alright, we keep our fingers crossed, next time s/he will do be better!*"; and negative statements: "*Considering the moderately good results throughout this season, during Olympic Game s/he performed rather badly. I think s/he wasn't sufficiently prepared to this tournament*." One month after closing ceremony of the Winter Olympic Games (2018), hating and non-hating persons received an invitation to participate in the psychological study via Facebook Messenger application.

Measures

In the present study, we aimed to test, whether online haters differ from non-hating persons. To test Dark Triad, we used the Jonason and Webster (2010) questionnaire; polish adaptation by Czarna et al. (2016). The Dark Triad questionnaire had a high reliability for all subscales: Narcissism (Cronbach's $\alpha = 0.89$); Psychopathy (Cronbach's $\alpha = 0.81$); Machiavellianism (Cronbach's $\alpha = 0.73$). Moreover, we also used the Satisfaction with Life Scale (Diener et al., 1985; Polish adaptation by Jankowski, 2015). In our study, the Satisfaction with Life Scale had high reliability (Cronbach's $\alpha = 0.85$). As there are no established scales that would measure the trait of interest – experienced frustration, for the purpose of the present research, we decided to construct a short Scale of Frustration. This scale included two questions: "*I often experience unpleasant emotions, for instance: anger, anxiety, pain, as a result of not being able to fulfill one of my desires*"; "*I often experience unpleasant emotions, for instance: anger, anxiety, pain, as a result of not being able to achieve highly valued goals.*"; and participants responded to each item on a seven-point Likert scale (ranging from 1 – "*I definitely disagree*," to 7 – "*I definitely agree*"). The two items were chosen based on the assumption that individuals experience frustration when they cannot fulfill their desires, or achieve their goals (Boyd, 1982; Crossman et al., 2009). The Scale of Frustration had a high reliability (Cronbach's $\alpha = 0.88$). The last scale, included in the present study, was the Scale of Envy, which was based on Tandoc et al. (2015) scale. We have used the three selected items: "*I do not think it is fair that some people have so much fun in their life, while others work really hard*"; "*Many people that do not deserve it, have a better life than me*"; "*Many people who do not deserve it, are happier than me.*" Participants responded to each item on a seven-point Likert scale (ranging from 1 – "*I definitely disagree*," to 7 – "*I definitely agree*"). The Scale of Envy was highly reliable (Cronbach's $\alpha = 0.89$).

RESULTS

Table 1 shows means and standard deviations of both groups (i.e., haters and non-haters). A general overview of relationships between psychological variables, examined in the present study, is presented in **Table 2**. Only two variables significantly correlated with each other: persons that scored high on Machiavellianism subscale also expressed strong narcissistic tendencies; persons that expressed high frustration also scored high on Scale of Envy. In the next step, logistic regression was performed in order to investigate, which variables may account for posting hating online comments (see **Table 3**). Results showed that the strongest predictor of hating online comments was the Psychopathy subscale ($\beta = 1.37$, $Z = 2.69$, $p < 0.001$), whereas the Scale of Envy was close to reaching the statistical significance ($\beta = 0.67$, $Z = 1.91$, $p = 0.056$).

DISCUSSION

In the present study, we sought to investigate whether certain psychological characteristics can predict posting hating comments online. Our results showed that high scores on the Psychopathy subscale was a significant predictor of posting hating

TABLE 3 | Binomial logistic regression on hating online comments.

	Hating online comments			
	β	*SE*	*Z*	*p*
Intercept	−3.70	2.21	−1.67	0.10
Age	0.00	0.02	0.23	0.82
Sex	−0.18	0.50	−0.36	0.72
Frustration	0.41	0.36	1.15	0.25
Envy	0.67	0.35	1.91	0.06
Narcissism	0.04	0.31	0.11	0.91
Psychopathy	1.37	0.51	2.69	0.01*
Machiavellianism	−0.08	0.38	−0.20	0.84
Satisfaction with life	−0.41	0.29	−1.42	0.16

*Estimates represent the log odds of "hating online comments = 1" vs. "non-hating online comments = 0." *$p < 0.05$.*

comments online; whereas age, sex, high scores on Frustration, Envy, narcissism, Machiavellianism, and Satisfaction with Life scales were non-significant predictors. Interestingly, high scores on the Scale of Envy almost reached a statistical significance (on the level of a strong trend).

Our findings are in accord with previous studies, which provided evidence that negative online behaviors are associated with high levels of Psychopathy, in case of, for instance: trolls (Buckels et al., 2014; Golf-Papez and Veer, 2017; Sest and March, 2017; March, 2019; Moor and Anderson, 2019), cyber-bullies (Goodboy and Martin, 2015), and persons who exhibit hate speech (Withers et al., 2017). This result may not be surprising, as Psychopathy is characterized by impulsivity and thrill-seeking behavior (Paulhus and Williams, 2002), hence, high levels of impulsivity may foster impetuous behaviors, such as expressing a negative, insulting attitude/opinion toward someone or something, which is evaluative but, at the same time, does not include constructive criticism. One of the examples that portrays online hating behavior is the case of Polish Winter Olympic Games contestants, who have been widely attacked for their (unsatisfactory from the fans perspective) performance (Przegląd Sportowy, 2018), leading to negative reactions from the sports players – for instance, one of the players posted a provocative post on her Twitter page (i.e., "*You don't know shit*"), which resulted in even more heated discussions on online hating, and its influence on mental well-being and performance of sports players (Kuczyński, 2018).

Interestingly, posting online hating comments was not associated with higher levels of other Dark Triad traits (i.e., Narcissism and Machiavellianism), which were reported to correlate with personal characteristics of trolls (Buckels et al., 2014; March, 2019), cyber-bullies (Goodboy and Martin, 2015), and persons who post hate speech comments (Withers et al., 2017). Moreover, a high level of frustration and a low satisfaction of life has been previously linked to aggression (Valois et al., 2006; Breuer and Elson, 2017). Thus, we expected that both traits would be linked to verbal aggression (associated with online hating), but no such relationships were observed in the present study. Analysis revealed that there was only a weak, positive relationship between envy and hating comments, while, contrary to previous research, envy was not related to any of the subscales of Dark Triad (Krizan and Johar, 2012). Also, gender was not a significant predictor of online hating, which contradicts previous studies (Buckels et al., 2014; Craker and March, 2016; Sest and March, 2017).

One of the limitations of our study is that it reflects personal characteristics of only sports fans, and not the general population. At the same time, we believe that is also the strength of the methodology of our study, as sport is an important area of life, in which the vast majority of societies actively participate (Van Tuyckom and Scheerder, 2010; Bin and Lanjuan, 2019). Nevertheless, future studies should also focus on collecting data from people of various walks of life, scoping more general and broad topics discussed online. Moreover, the present research was conducted only among Polish Internet users. Despite the fact that Poles are said to be rather similar to other, European societies (Gross, 2004), future cross-cultural studies could provide some further evidence that the present findings may be generalized also to other societies. It would be also interesting to collect data from trolls, cyber-bullies, persons who engage in hate speech, and haters, as this could allow for explicit comparisons between persons who exhibit derogatory behaviors online.

Considering a reported increase in online hating (Blaya, 2019), predictions are that online hating behavior will become even more and more severe. Results of the present study are one of the first steps in broadening our understanding who the online haters are, which, in turn, may help identifying the best strategies for psychological interventions for haters, and creating counter-hating strategies.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Review Board of the Institute of Psychology at the University of Wrocław. Written informed consent for participation was not provided by the participants' legal guardians/next of kin because: Ethical Committee of the Institute of Psychology (University of Wrocław) agreed that only the written consent of the participants (and not their legal guardian/next of kin) is required.

AUTHOR CONTRIBUTIONS

PS and AO: conception of the study. PS, MK, and PZ: data collection and the analyses. All authors contributed to drafting and reviewing the manuscript.

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Do Customers Pay Attention to Motivations and Switching Costs When They Terminate Their Relationships?

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Research on some key boundary conditions and outcomes of consumers' relationship termination in the online environment is scare. We examine how four categories (e.g., upkeep, time, benefits, and personal loss) of avoiding relationships affect customers' relationship termination. We also consider both the motivation (hedonic vs. utilitarian) and switching costs when customers evaluate whether to exit from or stay in a relationship. Results show that time plays a significant role in customers' relationship termination, but there appears to be an increase or decrease in customers' relationship termination associated with the role of two moderators. More specifically, upkeep plays a significant role in affecting relationship termination for consumers motivated by hedonic interests (as opposed to those motivated by utilitarian interests). Meanwhile, personal loss plays a role in affecting relationship termination for utilitarian consumers (and not hedonic). Furthermore, we found that high switching costs facilitate a relationship termination if time and personal loss are involved. The findings indicate that the effect of high switching costs on customer loyalty is limited. We also found that when consumers consider time category, they are likely to have a greater intent to terminate a relationship regardless of the level of switching costs.

Keywords: relationship termination, moderating effects, relationship avoidance, switching costs, motivations

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INTRODUCTION

Firms with improved digital experiences are more able to leverage their customer relationship management (CRM) profile to attain superior customer satisfaction outcomes (Srinivasan and Moorman, 2005). However, many managers at marketing and business conferences express concern about their performance and have been asking questions such as "Why is our CRM system failing?" and "Why do consumers not want to have a relationship with us?" Similarly, researchers also question the effectiveness of customer defection in a digital retail context (Srinivasan and Moorman, 2005; Ha and Janda, 2011). A fruitful way to further understand this issue may be to a glean further understanding of what consumers really want to avoid in their existing relationships (Fournier, 1998). In this case, relationship termination is related to the experience with or perception of a firm.

Numerous studies in psychology and marketing have addressed consumer behavior toward switching, fading, and terminating relationships. As highlighted in **Table 1**, researchers

investigating the relationship fading or termination focus mainly on the impact of cognitive and emotional variables such as expectations, quality perceptions, and negative feelings. Their focus on relationship fading and termination is on attitude movement in positive and negative directions (Evanschitzky et al., 2020). However, little is known about the actual psychological traits that drive relationship termination. Specifically, why and in what way consumers tend to terminate long-term relationships in online settings is a question that has not received enough empirical attention (Ashley et al., 2011). We use Noble and Phillips (2004) concept of relationship avoidance (i.e., upkeep, time, benefits, and personal loss) to further investigate the above research questions. Although their study provides insights into consumer types of avoidance in the traditional market context, their findings also help to further elaborate on relationship termination in the travel firm context. More specifically, testing the study of Noble and Phillips (2004) is adequate in the online travel firm context, where sharing communication about customer needs, interests, and concerns is needed.

There are several theoretical approaches to better understand relationship termination. Motivation theory may offer a useful framework when multiple needs remain unmet, resulting in frustration (Hanna and Wozniak, 2001). The use of social-exchange theories capable of explaining relationship termination in a digital consumer behavior setting has been somewhat limited. The notions of perceived effort and perceived loss may be useful in understanding the mechanism of relationship termination (Noble and Phillips, 2004) and privacy in online settings may be a critical trade-off in relationship performance (Winer, 2001; Ashley et al., 2011).

Although these theoretical frameworks can be adapted to the context of digital relationship termination, some unique aspects of this study present several new challenges. First, most digital firms have implemented tracking mechanisms that monitor whether a customer responds to CRM systems. Such systems may be useful for a more complete understanding of customer actions, but CRM systems cannot fully predict the feelings and behavior of consumers who terminate relationships. Furthermore, Noble and Phillips (2004) and Ha (2015, 2017) had mainly focused on key factors of relationship avoidance (or termination) from the cross-sectional to longitudinal perspectives. That is, research that has addressed relationship termination on the internet is limited, suggesting that this research area is still in its infancy. By a better understanding of relationship termination and how they relate to intent to terminate a relationship, we aim to fill in this gap and contribute meaningfully to the extant literature.

To synthesize the research in this domain, particularly, we look at the role of motivation (hedonic vs. utilitarian) and switching costs when customers evaluate their intent to leave or remain in a relationship. In particular, the efficacy of alternative moderating mechanisms is conditional on relational exchange factors (Poppo et al., 2016). The switching costs and shopping motivation associated with moderating mechanisms reflect relational termination impacts, especially in emerging markets where customer-oriented market supporting systems are underdeveloped (Ha and Lee, 2012). Furthermore, customer motivation and relevant costs related to relationship termination is still in its infancy in the tourism literature (Ha, 2017), indicating that a better understanding of two boundary conditions is mandatory. These moderators can play an important role in terminating or managing the current relationship with a website; thus, a more complete understanding of these factors can help marketing organizations in online settings further improve their marketing efforts and bolster the probability of maintaining a relationship with customers.

The remainder of this paper begins by addressing the research background, establishing research hypotheses, describing the research methodology, and testing the proposed hypotheses. This is followed by a discussion of the key findings, a summary of limitations, and an outline of future research directions.

CONCEPTUAL DEVELOPMENT

Background of Termination Behaviors

Although most researchers and practitioners recognize the value of relationship marketing (RM), the effectiveness of RM can depend on several factors such as prior customer–brand experiences (Fournier, 1998), risk avoidance (Gu et al., 2017), relationship avoidance (Noble and Phillips, 2004; Grégoire et al., 2009; Ashley et al., 2011; Ha and Lee, 2012; Ha, 2015, 2017), relationship fading (Evanschitzky et al., 2020), or anti-consumption behavior (Lee et al., 2009). This section starts with a summary of prior experiences that are well documented in the relationship marketing literature and subsequently presents a review of research related to digital relationship termination behavior.

A prior negative experience in an online setting may encourage the intent to end a relationship (Ha and Lee, 2012). Furthermore, Fournier (1998) found that the main reason of relationship ending is closely related to negative experiences with a particular brand. Therefore, a negative prior experience can become a critical element in the decision to enter or continue in a relationship if the negative performance fails to meet the accepted level of customer expectations (Zeithaml et al., 1993).

The connection between relationship termination and prior experience is that digital users will tend to patronize websites where they can easily assess performance, and in turn, they will end those that are difficult to judge. Thus, relationship termination is a result of perceived experience differences between positive and negative experience levels. That is, the bigger the perceived negative difference, the less likely a website will be selected.

Although the key assumption of relationship marketing is that consumers prefer to form a relationship to obtain desired benefits, many obstacles can hinder relationships with a website. One of these pertains to unenticing benefits, a situation where the customer feels that the benefits offered by the retailer are not sufficient enough to warrant the time and effort involved in maintaining the relationship (Noble and Phillips, 2004). This is also directly related to the anticipated benefits that address the relationship obstacles that result from failing to recognize

TABLE 1 | Overview of marketing literature highlighting the relationship fading and termination.

Authors	Context	Design	Key moderating variable	Key internal (mental) variable
Fajer and Schouten, 1995	B2C (product-related)	Conceptual	Level of loyalty	Unmet expectations for brand performance, changing Consumer needs/liking criteria
Fournier, 1998	B2C (brand)	Qualitative	–	–
Gronhaug et al., 1999	B2C	Three life-history cases	–	Perceptions of company, sales representatives
Mittal and Lassar, 1998	B2C (health/car repair)	Qualitative	Level of satisfaction/interpersonal interaction	Technical/functional quality perception
Hocutt, 1998	B2C (services)	Conceptual	Commitment	Reactance to high exit barriers, dissatisfaction
Roos, 1999	B2C (product)	Switching pass analysis	Irrevocable/revocable switching paths	Negative feelings (anger, distress, shame, stress, and dissatisfaction)
Tuominen and Kettunen, 2003	B2C (airline services)	Qualitative	Light/medium user	Overall service evaluations
Åkerlund, 2004	B2C (financial service)	Qualitative/quantitative	Economic climate, stock market conditions	Expectation, decreasing, commitment, dissatisfaction quality perception
Noble and Phillips, 2004	B2C	In-depth interview	–	Maintenance, time, benefit loss, personal loss
Monga and Houston, 2006	B2C (product)	Experimental	Prior attitude, performance ambiguity	Expectations change
Hollmann et al., 2015	B2B	Qualitative	–	Relationship external events
Leonidou et al., 2018	B2B relationships	Empirical	–	Negative feelings (anger, loss of trust, and disappointment)
Evanschitzky et al., 2020	B2C (fading stages)	Qualitative	–	Negative surprise, dissatisfaction, frustration, anger, distrust
This study	B2C (travel)	Empirical	Level of shopping motivations/ switching costs	Upkeep, time, benefit, personal loss

purported benefits or having concerns about whether sustaining a relationship is worthwhile (Ashley et al., 2011).

Both anti-consumption and anti-choice behaviors may be useful for a complete understanding of relationship termination with certain products or brands. Take the instance of a consumer visiting a website (or downloading a mobile application) that offers attractive benefits; however, he/she is disappointed because that which was offered has either sold out or gone away after a promotional period. As with the expectation–performance linkage of services proposed by Zeithaml et al. (1993), undesirable behavior usually occurs when unmet expectations lead to negative first-hand consumption experiences (Lee et al., 2009). This is linked to a prevention focus for avoiding risks associated with future negative consequences (Briley and Wyer, 2002).

Furthermore, the concept of marketing avoidance is beneficial in explaining consumers' desire to shield themselves from marketing promotions and protect privacy (Hann et al., 2008). As Fournier (1998) noted, avoidance behavior to protect consumer privacy is often caused by firms' marketing activities that impose inconvenience or other negative outcomes for consumers (Hann et al., 2008). Given that these activities are perceived to be undesirable by consumers, they may motivate consumers to avoid having a relationship with the firm (Ha and Lee, 2012). For this research stream, the approach avoidance framework has demonstrated the negative implications of undesirability for achievement-related outcomes (Roney et al., 1995; Elliot and Sheldon, 1997), resulting in the reinforcement of avoidance behavior.

Table 2 distinguishes this study from the only two other studies that have mainly focused on relationship avoidance behavior from the traditional market (Noble and Phillips, 2004) and online market (Ha, 2017). In general, this study is the first to focus on the role of motivation and switching cost in decisions to end a relationship. In particular, we provide theoretical and managerial contributions for extending the literature.

Relationship Termination

Relationship termination is a more advanced construct than are ones centered on the theme of anti-relationship. The former focuses on the actual negative attitude toward an entity (e.g., firm, online marketer), whereas the latter focuses on critical obstacles that negatively affect relationship building. Relationship termination is thus defined here as "a consumer's attitudinal desire to exit the relationship with a particular website." This definition is consistent with Park (2010) finding that, when people experience or face negative consequences, they may respond with avoidance-motivated goals that are consistent with their underlying motivations. These avoidance-motivated goals

TABLE 2 | Studies that focus on four themes of relationship avoidance.

	Noble and Phillips, 2004	Ha, 2017	This study
Consideration of an interaction between four themes and relationship exit	×	×	v
Consideration of relationship exit	×	×	v
Consideration of moderating variables	×	×	v
Key objective	Identify drawbacks to the consumers, which is a critical endeavor for understanding why consumers avoid relationship building programs.	Investigate relational dynamics between four themes and relationship avoidance over time.	Exam how relationship avoidance influences customer intent to leave and how moderators involve in the proposed relationships.
Key findings	Four themes of relationship hindrance (e.g., upkeep, time, benefit, and Personal loss themes).	Upkeep theme is insignificant, whereas time and personal loss themes play a crucial role in terminating the relationship.	Upkeep losses are not significant, whereas time and benefit losses influence customers' intent to leave. Both utilitarian and low switching cost play an important role in bridging the proposed relationships.
Key implications for future research	Investigate long-term relationships, which might be difficult to exit.	Identify key moderating factors that can change in the relationship between four themes and relational exit.	Cultural difference and point of purchase should receive more attention.

should be either directly or indirectly linked to forming a negative attitude toward a particular object (Gable, 2006; Impett et al., 2010). It is also postulated that a gap between consumer expectations and these reasons will facilitate the formation of a negative attitude.

Even though relationship termination may still be an unfamiliar construct in the marketing literature, research on the topic has been garnering attention in psychology, organizational behavior, and marketing. Consumers will likely avoid uncertainty in some types of relationships and are likely to evaluate such relationships in terms of perceived loss and perceived effort (Noble and Phillips, 2004). Consumers tend to make a trade-off between perceived loss and effort. Perceived loss is a critical construct because it can contribute to consumer dissatisfaction with a firm (for instance, when using websites or mobile applications) and over time lower the probability of forgiveness (McCullough et al., 2003) and raise the likelihood of relationship endings (Grégoire et al., 2009). It thus seems fruitful to further understand conditions that lead consumers to seek relationship avoidance and how that affects the intent to end a relationship.

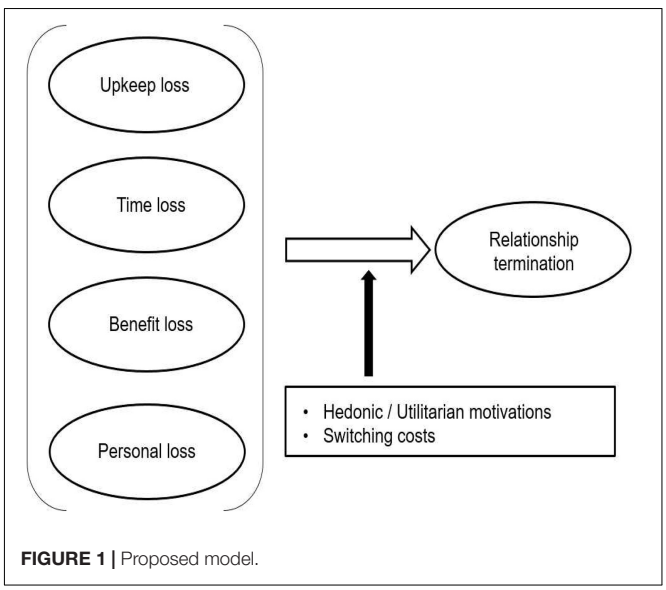


FIGURE 1 | Proposed model.

Research Hypotheses

The proposed research model is derived from the literature on consumer behavior in online shopping and relationship contexts (**Figure 1**). Relationship termination may arise from a variety of factors that have been well articulated by Noble and Phillips (2004). According to Noble and Phillips (2004), upkeep reflects the annoying tasks that consumers feel they have to engage in, to maintain their relationship with a provider. Time represents the time required to initiate or maintain a relationship with a website (or mobile application). Benefit represents a consumer's belief that some problem exists with the benefits offered through relational programs. Finally, personal loss represents consumer perception of loss associated with privacy and/or social issues.

Relationship termination is closely related to a consumer's belief that there is some relationship loss in a current relationship or potential relationship with a particular website (or mobile application). Attachment theory draws from personal relationship research to suggest that when environmental conditions change in an unexpected and/or threatening manner, a series of behaviors can potentially be triggered in which people

often reestablish their behavioral patterns (Hazan and Shaver, 1992). The concept of relationship loss plays a central role in research streams such as the personal relationship-based view, relationship marketing, neural science, behavioral economics, and psychological dynamics (Schoenbachler and Gordon, 2002; Tom et al., 2007; Adams et al., 2008).

As the relational obstacles increase, relationship termination generated by time losses, benefit losses, and psychological losses becomes more tacit. For example, customers are reluctant to waste time on a website to maintain a relationship. However, most website practitioners often misunderstand the importance of time convenience. This suggests that they must improve time convenience to keep customers as customers are afraid to lose their precious time (McKeown, 2002). An economic benefit is another example. If relationship maintenance becomes more difficult, users may consider abandoning the relationship (Evanschitzky et al., 2020). In sum, these three loss categories that constitute relationship termination essentially should reflect the important role of personal loss in the relational process. Thus, we propose the following three hypotheses:

H1. Time loss is positively associated with relationship termination
H2. Benefit loss is positively associated with relationship termination
H3. Personal loss is positively associated with relationship termination

However, arguably, these four loss categories may not equally influence customer's intent to leave, because these types are dynamic over time. For example, a recent study empirically illustrates that the upkeep loss category does not exist for customer relationship termination over time (Ha, 2017). Because most digital users are well aware of this issue, they are more likely to ignore upkeep category compared with the initial stages of online shopping or tend to form indifferent attitudes toward system processes. This trend leads to relationship maintenance crisis. Customers may misunderstand the website strategies by believing that the maintenance announcement is ineffective. In the study, we propose the method to limit the effect of the upkeep loss category on relationship termination. Thus, we propose the following hypotheses:

H4. Upkeep loss is not positively associated with relationship termination.

Moderating Role of Hedonic/Utilitarian Motivations

Web-usage theory (Cotte et al., 2006) provides the underpinning theoretical perspective on the role of hedonic/utilitarian motivations in affecting the linkage between relationship loss and relationship endings. According to this framework, individuals form a motivational foundation for their continued participation in or interactions with a particular website, thus suggesting that their hedonic/utilitarian motivations determine their future behavior (Pöyry et al., 2013). Furthermore, the nature of relational participation will affect motivation for decisions aimed toward avoiding post-behavioral negative consequences (Simonson, 1992). Utilitarian motivations will thus focus on the efficiency of achieving specific goals and minimizing inefficiencies.

Since efficiency is related to utilitarian motivations, customers are likely to be more tolerant of other features of the online (or mobile) experience as long as efficiency is maintained. This allows utilitarian customers to minimize their potential losses. From an efficiency perspective, upkeep and benefit losses are principally utilitarian, which customers often use for almost purely functional purposes (Rychalski and Hudson, 2017). For example, if a customer perceives potential functional losses in a relationship, the customer is likely to terminate the relationship. Thus, we propose the following two hypotheses:

H5. Customer motivations positively moderate the effect of upkeep loss on relationship termination.
H6. Customer motivations positively moderate the effect of benefit loss on relationship termination.

Meanwhile, hedonic motivations will lead to a greater emphasis on the flow experience (Novak et al., 2003) as opposed to utilitarian motivations that would emphasize efficiency (Cotte et al., 2006). The flow experience characterized by exploratory browsing, which can involve variety seeking and risk taking is central to a hedonic motivation, will allow the customer to be more inclined to immerse himself/herself in this flow. However, hedonic customers are more sensitive to a relationship, especially when they have dissatisfied experience. They will not return to a website owing to their bad experience (Bougie et al., 2003). In this study, customers motivated by negative hedonic motivations such as time loss and personal loss traits are likely to terminate a relationship if they have dissatisfied experience or do not feel real entertainment. As such, these two categories will have a greater effect on intent to terminate a relationship (Novak et al., 2000; Voss et al., 2003). Thus, we hypothesize the following:

H7. Customer motivations positively moderate the effect of time loss on relationship termination.
H8. Customer motivations positively moderate the effect of personal loss on relationship termination.

These hypotheses, H5–H8, mean that hedonic and utilitarian motivations positively moderate the effect of upkeep loss (other three loss categories such as time, benefit, and personal loss). Because this study identifies two groups, namely hedonic and utilitarian motivations, it is possible that a customer may have hedonic and utilitarian motivations both, either hedonic or utilitarian motivations only. To reconcile these issues, this study especially compares the differences of the moderating effects between the two groups.

Moderating Role of Switching Cost

Switching cost is defined here as the perception of the degree to which additional economic, psychological and emotional costs are required to terminate the current relationship and secure an alternative (Sharma and Patterson, 2000; Jones et al., 2002). Prior research suggests that the moderating effect of switching costs is useful for a better understanding of the customer relationship

process (Lee et al., 2001; Jones et al., 2002). When switching costs are particularly high, customers would find the thought of switching particularly painful. Hence, customers will learn how to take the necessary economic and behavioral steps to maintain their current relationships (Yang and Peterson, 2004).

Conversely, when switching costs are perceived to be low, customers will be less inclined to invest the time and effort (e.g., upkeep and benefit) to maintain the relationship. Thus, upkeep, time, and benefit loss categories accelerate the dissolution because switching costs have a potential ability to end the relationship (Halinen and Tähtinen, 2002). Furthermore, a switch or transaction termination will conditionally occur if a customer perceives any anxiety and fear (Ongena and Smith, 2001). This is also conditional if switching costs are low as customers may be reluctant to defect the current relationship with other service providers owing to high switching costs. Thus, four categories will be more strongly related to intent to terminate a relationship. Accordingly, we propose the following hypothesis:

H9. Switching costs positively moderate the effect of upkeep on intent to leave a relationship.
H10. Switching costs positively moderate the effect of time on intent to leave a relationship.
H11. Switching costs positively moderate the effect of benefit on intent to leave a relationship.
H12. Switching costs positively moderate the effect of personal loss on intent to leave a relationship.

RESEARCH METHODS

Research Setting

The research setting for data collection involved digital travel markets operated by large-scale travel companies in South Korea. Unlike smaller travel markets in South Korea, most travel markets that use digital platforms are designed, communicated, and are managed very systematically. For such markets, however, the switching costs are relatively lower than for single-owned small markets (Park and Ha, 2012). Therefore, CRM among travel markets is a fundamental priority, because South Korean travel markets have become extremely competitive due to the presence of global markets such as expedia.com, tripadvisor.com, hotels.com, and trivago.com. As such, this research setting is particularly desirable for examining the nature of relationship avoidance.

Data Collection

We collected data from an online market-research firm (tillionpanel.com) to gain access to commercial market users. The research firm contacted digital market users across South Korea (within its 428 panelists who met the study's criteria), and 300 users agreed to participate. All participants were registered on digital commercial websites (via either a computer or a mobile device) and had a minimum of 6-month browsing experience prior to data collection, indicating that they were eligible for inclusion in the study.

We employed a short-term data-collection procedure to minimize any possible response bias. Meanwhile, to ensure that respondents answer all questions (and to eliminate missing responses), we embedded a survey platform that did not allow respondents to move on to the next question if they did not respond. Thus, data were collected from these experienced users for the third week of February 2016. Respondents aged 21–59 years were asked to participate; approximately 40% were males and 60% were female. Of the respondents, 31% had a monthly income below US$2,000. The income of the remaining 69% broke down as follows: US$2,000–3,000 (25%), US$3,000–4,000 (15.7%), US$4,000–$5,000 (11%), and >US$5,000 (17.3%). Finally, approximately 67.2% of respondents used mobile platforms when they shopped.

We also checked the data for differences between the travel groups. First, we assessed the non-response bias by analyzing the differences between the respondents (n = 300) and non-respondents (n = 128) for key descriptive variables. No significant differences were found between the two groups in terms of age (p = 0.14) or gender (p = 0.19), indicating no non-response bias in the data. This study maintained disaggregated individual-level data from these results.

Measures

The independent variables modeled to influence customers' intent to leave are the four relationship avoidance categories: upkeep, time, benefits, and personal loss. In addition, hedonic/utilitarian motivations and switching costs were included as moderating variables. All constructs were obtained on a five-point Likert scale with range "1 = *strongly disagree*" to "5 = *strongly agree.*"

Noble and Phillips (2004) did not originally develop the four categories of relationship avoidance, whereas Ha (2015) developed full scales of relationship avoidance based on Noble and Phillips (2004) original avoidance categories. However, several sub-dimensions have been modified, because customer behavior and IT development have rapidly changed. As shown in Appendix, the items of four categories used in this study were measured using Ha (2015) new measurement scales. More specifically, upkeep was measured using four items of two sub-dimensions such as account maintenance and unnecessary requirements, which have been widely used in the retail and digital marketing literature (Noble and Phillips, 2004; Ha and Janda, 2011; Ha, 2015). Time was measured using four items with the two sub-dimensions: tiring initiation and discordance of/information search. Tiring initiation is directly linked to the initiation, as proposed by Noble and Phillips (2004), but discordance of/information search is new because the original two categories of accumulation and travel were mainly focused on traditional retailing contexts (offline markets). Benefit was measured using five items related to three sub-dimensions (preconditions, poor benefits, and relative suspicion). These categories are very similar to Noble and Phillips (2004) avoidance of purchase requirements (hollow, unenticing, and unknown). Personal-loss was measured using four items with the two sub-dimensions of personal information exposure and technical anxiety. Personal information exposure is widely accepted in

marketing, IT, and psychological studies, whereas technical anxiety is new and its relevance has been pointed out in recent literature (see Pavlou, 2003; Lee et al., 2011).

Intent to leave was originally developed from the business-to-business (B2B) relationship literature and has been operationalized as the propensity to terminate the primary relationship partner (Ping, 1993). The notion of customers' intent to leave in this study was very similar to the B2B intent to leave; hence, the original scales were adapted, and the final version used three items.

We included two variables to investigate the moderating effects in the relationship between relationship avoidance and its outcomes. Hedonic/utilitarian motivations were measured using four items of the utilitarian/hedonic motivations adapted from Babin et al. (1994); Cardoso and Pinto (2010), and Yim et al. (2014). We identified two groups (hedonic and utilitarian motivations) by calculating the mean from four items (M = 3.84; hedonic motivation = 153 vs. utilitarian motivation = 147). Switching costs were measured using three items adapted from Jones et al. (2000). Similarly, two groups (low switching costs vs. high switching costs) were identified by calculating the mean (M = 3.11; low switching costs = 153 vs. high switching costs = 147).

Measure Validation

We used the confirmatory factor analysis (CFA) using AMOS 21.0 to assess convergent validity, discriminant validity, and reliability of the constructs. As shown in Appendix, all construct measures showed good psychometric properties. For example, all Cronbach's alphas were acceptable, indicating that they had high reliability.

We tested measurement validity using an estimated CFA model that included all constructs. The overall model fit was significant, $\chi^2(303) = 666.463$ ($p < 0.001$), and other indices showed good fit (CFI = 0.939, TLI = 0.909, and RMSEA = 0.067). Based on these statistics, the first step was to evaluate convergent validity by inspecting item loadings. All items loadings were in the range 0.656–0.880, and thus exceeded 0.6, which is the suggested threshold value (Fornell and Larcker, 1981). Next, we calculated composite reliability (CR) using the procedure suggested by Fornell and Larcker (1981). All CRs were above the threshold (CR > 0.7), and the average variance extracted (AVE) also exceeded the threshold value of 0.5, indicating that the measurement model had a good internal consistency. Finally, we assessed the discriminant validity as suggested by Fornell and Larcker (1981). As shown in **Table 3**, the smallest AVE exceeded the highest squared correlation in the correlation matrix, providing evidence for discriminant validity.

Control Variable

Gender was used as a control variable to reduce the alternative hypotheses in the proposed relationships. The control variable was measured by the gender difference (male vs. female) to investigate the difference in relationship termination. Gender is measured in B2C studies.

Common Method Bias

As upkeep and time losses are highly correlated when measured in the same survey, we checked common method bias in surveys. We performed Harman's one-factor to test this correlation. In so doing, we input all self-report variables into a principal component factor analysis using varimax rotation to clarify the relationship between factors. Our analysis revealed a seven-factor structure in which each factor was less than 50% of the covariation. We concluded that no general factor was apparent.

Data Analysis

We first used structural equation modeling (SEM) to test path analysis for observed variables without moderators. We used SEM without moderators to select the best model compared with other alternative models. As most structural modeling is nested, the priority is to compare their research models with the alternative model (Lin et al., 2017). Moreover, previous studies rarely used SEM to test interaction hypotheses (e.g., Bell et al., 2005; Eisingerich and Bell, 2008). Alternative mixed tests are performed using other analytic approaches (Tomarken and Waller, 2005). We applied PROCESS because our proposed model represents two conditional processes (Hayes, 2013). This study particularly focuses on the conditional effect. It estimates how much two cases that differ by one unit on an independent variable are estimated to differ on a dependent variable when a moderator equals some specific value (Hayes, 2012, p. 5). Recently, studies and academic conferences recommended that PROCESS is a useful approach to test conditional effects and the index of moderated mediation (Hayes et al., 2017).

RESULTS

The Structural Model and Hypotheses

We analyzed the proposed model without moderating effects (Model 1). In particular, we additionally tested an alternative model without the direct effects of the four categories for the outcome variable (Model 2). That is, Model 2 was a hierarchical model of relationship avoidance with four categories. Model 1's overall statistics indicated that the model was a good fit for the data [$\chi^2(166) = 440.155$, $\chi^2/df = 2.651$; CFI = 0.913; TLI = 0.898; RMSEA = 0.077]. Similarly, Model 2 indicates an acceptable fit of the model to the data [$\chi^2(165) = 475.711$, $\chi^2/df = 2.883$; CFI = 0.858; TLI = 0.821; RMSEA = 0.081]. As shown in **Table 4**, we investigated Models 1 and 2 using completely standardized path coefficients.

The proposed model (Model 1) uncovers some interesting results. The first was to check the effect of the control variable, revealing that gender was insignificant. This finding indicates that gender differences are homogeneous. Next, we considered the link between four-loss categories and relationship termination with the limited effect of upkeep in H4 (H1–H4). As expected, three categories of relationship termination were positively significant (H1: time, ß = 0.340, $p < 0.01$; H2: benefit, ß = 0.325, $p < 0.01$; H3: personal loss, ß = 0.177, $p < 0.01$). However, the upkeep loss category on relationship termination was insignificant (H4: ß = 0.111, $p > 0.05$). These effects are

TABLE 3 | Measurement information and correlation matrix.

Construct	Mean (SD)	1	2	3	4	5	6	7
1. Upkeep loss	2.80 (1.21)	**0.570**	–	–	–	–	–	–
2. Time loss	2.79 (1.12)	0.687	**0.527**	–	–	–	–	–
3. Benefit loss	3.13 (1.12)	0.284	0.330	**0.533**	–	–	–	–
4. Personal loss	3.57 (1.15)	0.422	0.436	0.635	**0.594**	–	–	–
5. Relationship termination	2.30 (1.02)	0.280	0.416	0.318	0.121	**0.604**	–	–
6. Hedonic/utilitarian motivations	3.84 (0.71)	-0.080	-0.043	-0.047	0.039	0.031	**0.508**	–
7. Switching costs	3.11 (0.91)	0.001	-0.121	0.105	0.084	0.030	0.099	**0.606**

Bold numbers on the diagonal show the AVE.

TABLE 4 | Results of estimated path coefficients.

	Standardized coefficient	Hypothesis	Support
Model 1: Proposed model			
Control variable			
Sex	0.061 (ns)	–	No
Time loss ? Relationship termination	0.340**	H1	Yes
Benefit loss ? Relationship termination	0.325**	H2	Yes
Personal loss ? Relationship termination	0.177**	H3	Yes
Upkeep loss ? Relationship termination	0.111 (ns)	H4	No
Model 2: Alternative model			
Relationship loss ? Relationship termination	0.409**	H1	Yes
Model comparison	AIC	BIC	
Model 1	1,028.155	1,191.122	
Model 2	1,235.461	1,422.598	
	?AIC = 207.306	?BIC = 231.476	

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

particularly notable, when consumers have potential relationship termination. These findings were also valuable because the effects of upkeep category in the results of H4 were very limited. This highlights the need to reconsider the relevance of upkeep in the context of online consumer behavior.

Meanwhile, our findings were supported by the results of Model 2. However, Model 2 had a weakness in addressing H4 because Model 2 could not give a detailed account of the differences for each effect of the four loss categories. This led to a comparison of the accuracy of these two models, through which both AIC and BIC were adopted to select the best model. As shown in **Table 3**, ?AIC and ?BIC were both well above the recommended threshold value of 10 (Burnham and Anderson, 2002). Thus, the proposed model (Model 1) exhibited a suitably better fit for the data and provided additional support for our hypotheses about the differing effects of these four loss categories.

Moderating Effects and Hypotheses

To test the moderating effects (i.e., H5–H8 and H9–H12), we conducted PROCESS analysis as proposed by Hayes (2013), where bootstrap was used to test a moderation effect. This approach is beneficial to test hypotheses about the mechanisms behind causal effects, which describes and explores the conditional mechanisms by which causality operates.

H5, H6, H7, and H8 predicted the positive moderating effect of customer motivations between four categories and relationship termination. As shown in **Table 5**, most moderating effects of customer motivations on the four categories–relationship termination link were statistically supported; however, the effects of customer motivations were split by the different roles of hedonic/utilitarian motivations. More specifically, similarities and differences exist between hedonic and utilitarian motivations. Although the upkeep–relationship termination link (H5: ß = 0.354, $p < 0.05$) is only positively improved by the moderating role of hedonic motivations, the personal loss–relationship termination link (H8: ß = 0.410, $p < 0.01$) is only positively improved by the moderating role of utilitarian motivations. As shown in **Figures 2A,D**, there appears to be an increase in customers' relationship termination associated with the high level of hedonic/utilitarian motivations. Both the benefit–relationship termination (H6: hedonic, ß = 0.340, $p < 0.05$ vs. utilitarian, ß = 0.236) and time–customers' relationship termination (H7: hedonic, ß = 0.296, $p < 0.05$ vs. utilitarian, ß = 0.420, $p < 0.01$) links are positively moderated by two motivations. However, as shown in **Figure 2B**, when a customer has a more utilitarian focus in the time category context, then relationship termination increases.

Hypotheses, H9–H12, posit that switching costs positively moderate the relationship between four categories and relationship termination. Apart from the three insignificant effects in two groups, most five paths were significant. That is, H10, the time–relationship termination link, was supported in both low and high switching costs, whereas the other three hypotheses, H9, H11, and H12, were partially supported.

There were differences that could increase or decrease the proposed relationship rather than the effects of hedonic/utilitarian motivations. Although both the upkeep–relationship termination (H9: ß = 0.447, $p < 0.01$) and the benefit–relationship termination links (H11: ß = 0.402, $p < 0.01$)

TABLE 5 | Conditional effect of four categories on relationship termination at values of the moderators (by PROCESS = 1).

Path	Motivations		Significance	Original interaction
	Hedonic	Utilitarian		
H5: Upkeep loss ? Relationship termination	0.354*	0.034 (ns)	Partially supported	0.320*
H6: Benefit loss ? Relationship termination	0.340*	0.236*	Fully supported	0.103 (ns)
H7: Time loss ? Relationship termination	0.296*	0.420**	Fully supported	0.123 (ns)
H8: Personal loss ? Relationship termination	0.140 (ns)	0.410**	Partially supported	0.279*
	Switching costs		Significance	Original interaction
	Low	High		
H9: Upkeep ? Relationship termination	0.447**	0.082 (ns)	Partially supported	0.530**
H10: Time ? Relationship termination	0.365**	0.373**	Fully supported	0.012 (ns)
H11: Benefit ? Relationship termination	0.402**	0.083 (ns)	Partially supported	0.319*
H12: Personal loss ? Relationship termination	0.207 (ns)	0.359**	Partially supported	0.151 (ns)

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

are only positively improved by the moderating role of low switching costs, the personal loss–relationship termination link (H12: ß = 0.359, $p < 0.01$) is only positively improved by the moderating role of high switching costs (see **Figures 3A–D**).

Interestingly, a similarity exists between motivations and switching costs. Time was involved in relationship termination, regardless of the role of either moderator. Furthermore, when a customer was more focused on the high switching cost rather than low switching costs, there appeared to be a decrease in the customers' relationship termination; however, high switching costs do not indicate customer loyalty, because both time and personal loss facilitate customers' relationship termination.

DISCUSSION

Summary of Findings

Our empirical findings from digital consumers establish that relationship loss can significantly affect intent to leave a relationship. These findings are consistent with the literature in marketing and psychology (Fournier, 1998; Noble and Phillips, 2004; Ha and Lee, 2012), but differences also exist in the literature (Ha, 2017). For example, Ha's study (2017) demonstrated that the overall effect of upkeep loss decreases, whereas our findings show that hedonic motivations and low switching costs positively moderate upkeep on customers' relationship termination. Specifically, these two moderators in this study increase the relationship between upkeep loss and customers' relationship termination.

Furthermore, the effect of upkeep, benefit and personal-loss on relationship termination also depends on the level of switching. Specifically, we found that high switching costs facilitate relationship termination relatively if time and personal loss are involved. The findings indicate that the effect of high switching costs on customer loyalty is limited. We also found that when consumers consider time loss category, they are likely to have greater intent to terminate relatively regardless of the level of switching costs. The following section provides an overview of both the theoretical and practical implications of these findings.

Theoretical Implications

Results of this study have implications for literature related to CRM, which thus far mainly focuses on either a negative relationship (Noble and Phillips, 2004), or non-relationship behavior (Ha and Janda, 2011; Ha, 2015). Conceptually, our study makes a contribution by looking at an important outcome (relationship termination) and exploring how the four loss categories (upkeep, time, benefit, and personal loss) influence this outcome. We also look at the moderating role of two relevant factors (utilitarian vs. hedonic motivations, and switching cost) and how these factors affect the relationship between relationship loss and relationship termination.

We found empirical evidence that relationship termination increases when both hedonic motivations and low switching costs are involved in upkeep. The significant increase between upkeep and relationship termination implies that the consideration of hedonic motivations and low switching costs in deciding whether to leave leads to active moderating effects and thus may facilitate a strong relationship termination. These findings contribute to extant motivation research, which largely focuses on consumer switching behavior (Chiu et al., 2005).

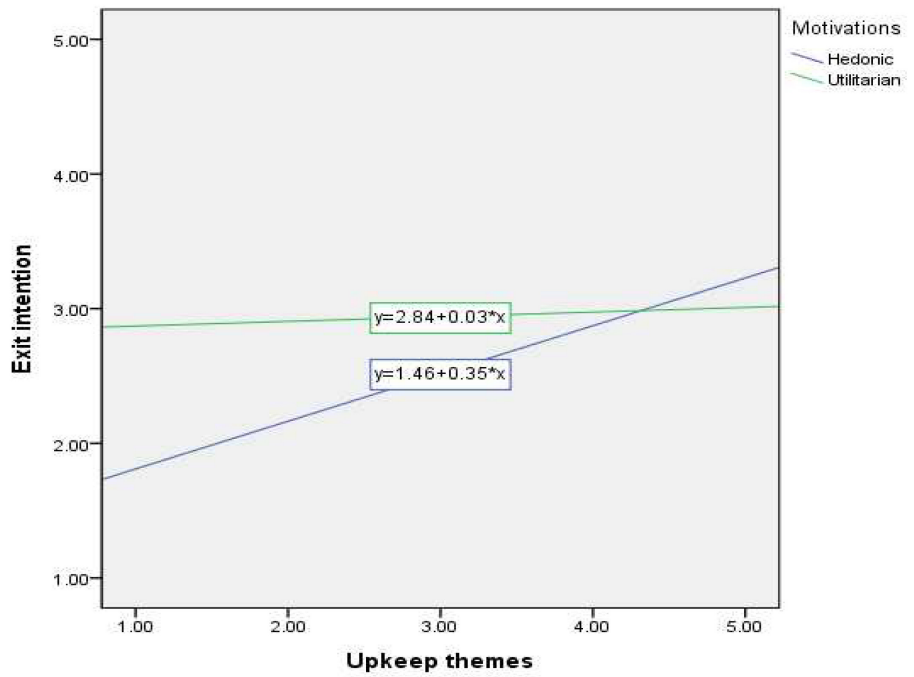
For theory, the findings bolster the effect of high switching costs by highlighting aspects that prior studies have scarcely considered. Most researchers agree that high switching costs are a useful approach not only for explaining the key effect of CRM on customer loyalty but also for understanding how high switching costs protect customers from competitors. Given that time and personal-loss represent a positive relationship termination, by showing that high switching costs increase the relationship between these two categories and relationship termination, we offer evidence for this overestimated effect of switching costs.

Finally, we advance the better understanding of switching costs in the customer-firm value link. We extend this study by establishing the moderating roles of a relational exit context. In particular, the consideration of high switching costs (together with the consideration of low switching costs in the benefit circumstance) helps to elaborate research findings suggesting that switching costs have only a weak negative influence on relational exit and actual switching (Pick and Eisend, 2014). Specifically, the results reveal that low switching costs only work if customers consider

valuable benefits from their relationships. As such, we conclude that researchers can use different switching cost levels to explain value offerings, not only an overall effect of switching costs.

Practical Implications

This study provides a better managerial understanding of how to manage three loss categories (time, benefits, and personal loss) best in an attempt to implement an effective CRM program



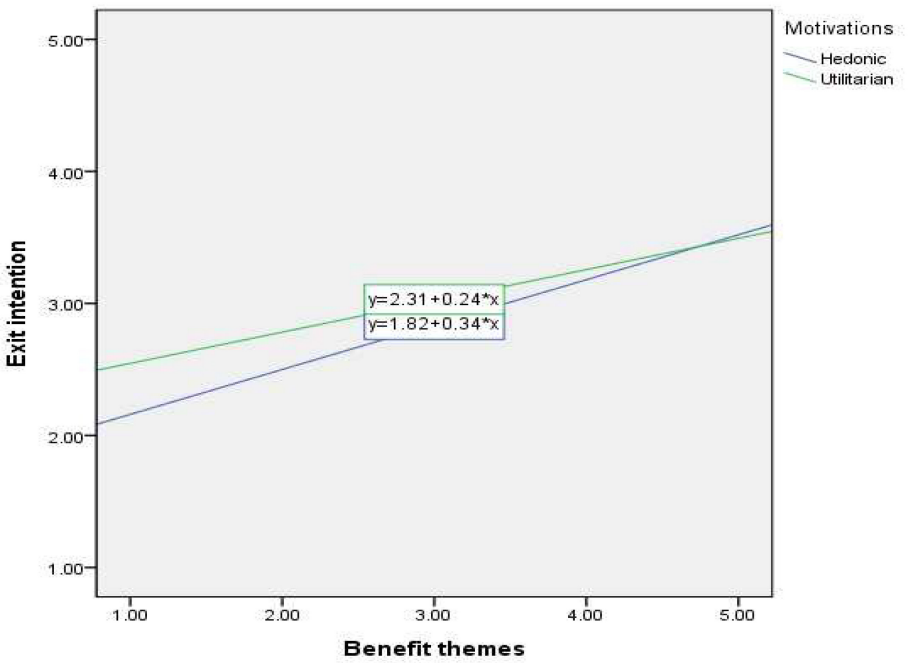
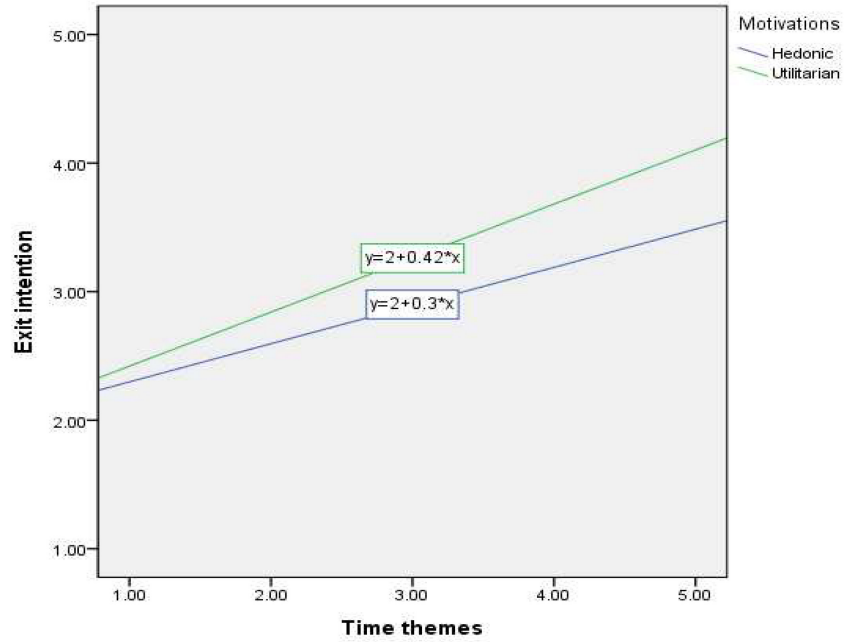


FIGURE 2 | Continued



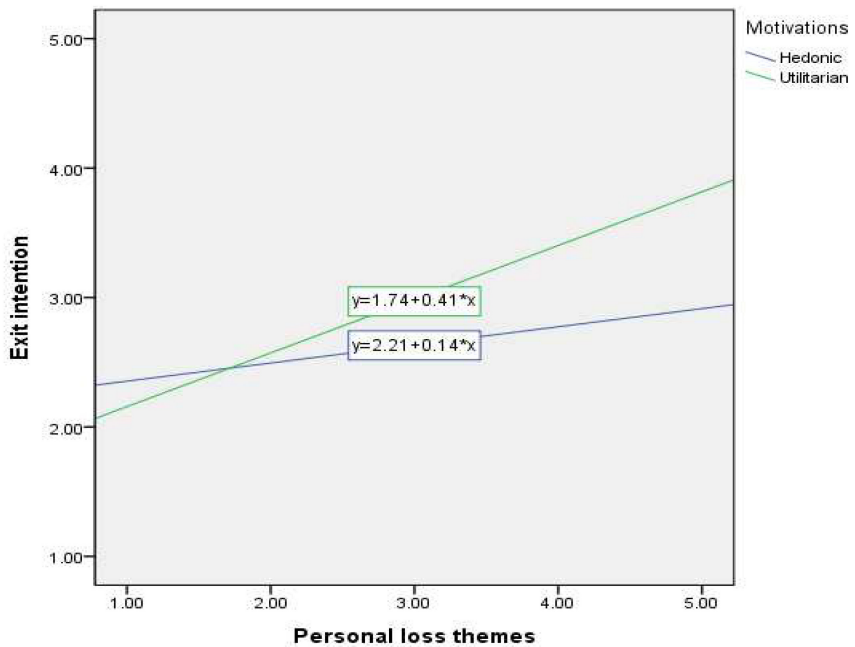


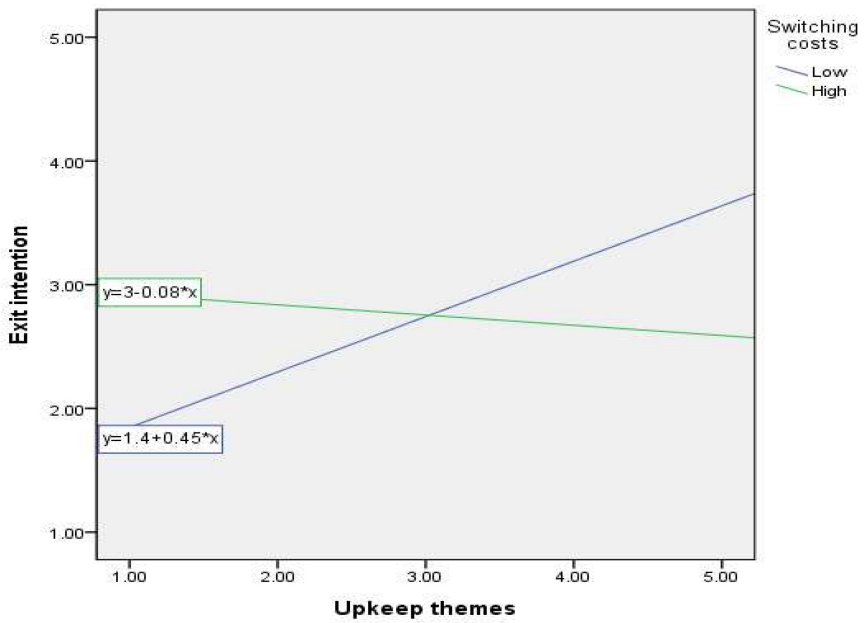
FIGURE 2 | (A) The moderating role of hedonic/utilitarian motivations (H5: Upkeep). **(B)**The moderating role of hedonic/utilitarian motivations (H6: Benefit). **(C)** The moderating role of hedonic/utilitarian motivations (H7: Time). **(D)** The moderating role of hedonic/utilitarian motivations (H8: Personal loss).

and reduce the probability of a customer intending to leave a relationship. Our study indicates that the upkeep category does not directly affect relationship termination; thus, less attention should be paid to this theme when designing CRM systems and more to improving time, benefit, and personal loss. However, upkeep should be considered in situations where it is known that a consumer is primarily motivated by hedonic concerns. As **Figures 2C,D** indicate, we also found that time and personal-loss could lead to a relationship termination for consumers with a utilitarian motivation. Because utilitarian consumers care for

time and benefit in addition to personal loss, marketers need to be mindful of designing online/mobile platforms that minimize hassles (such as update requirements).

Our findings also confirm that benefit solves the CRM dilemma: that is, firms do not handle most types of CRM strategies for customer care. The findings facilitate firms' choice and concentration in the face of CRM performance. In addition, people are likely to avoid negative emotional and financial consequences when they connect to a deep commitment with a specific object (Strachman and Gable, 2006). Thus, both shopping motivation and switching cost moderate the relationship between relationship loss and the relationship termination.

Furthermore, our findings show that relational loss categories lead to terminate a relationship when switching costs are low.



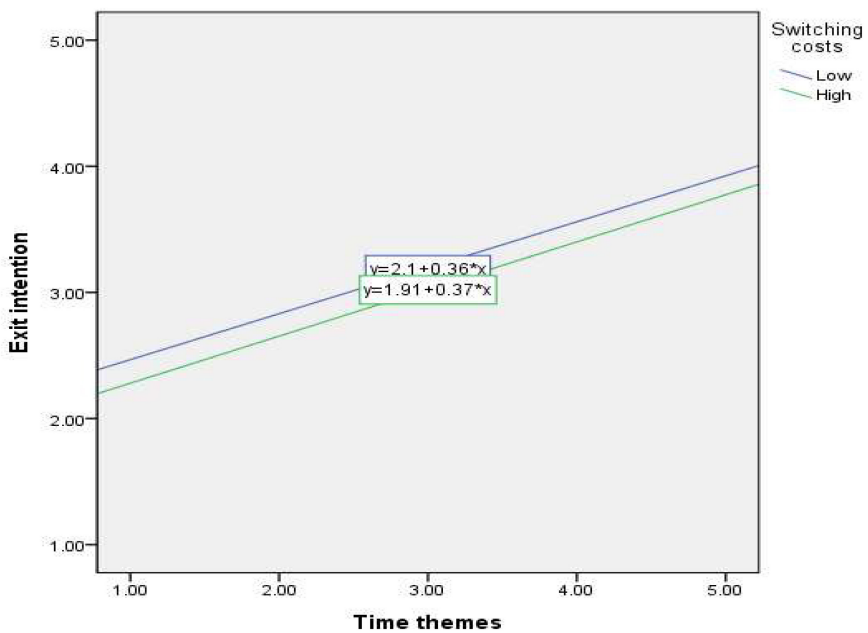


FIGURE 3 | Continued

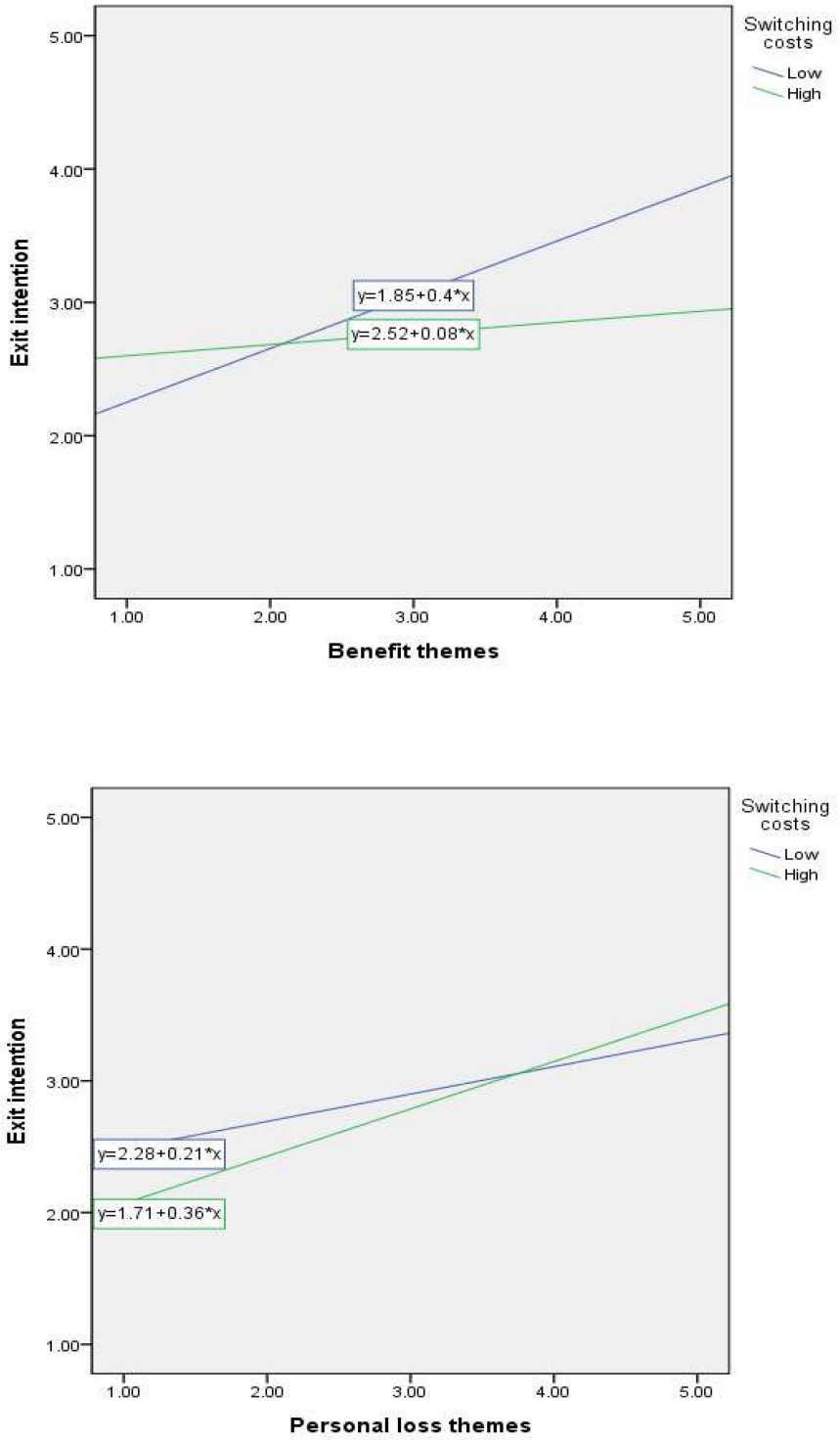


FIGURE 3 | (A) The moderating role of switching costs (H3: Upkeep). **(B)** The moderating role of switching costs (H3: Time). **(C)** The moderating role of switching costs (H3: Benefit). **(D)** The moderating role of switching costs (H3: Personal loss).

However, high switching costs do not guarantee customer loyalty. Genius loyalty program is an example in the Booking.com reward program, offering big discounts and free stay based on customers' booking records. This program is designed to stop customers from switching to competitors. However, many global travel competitors offer similar programs (e.g., silver and gold level

from Expedia.com), showing that it is difficult to differentiate switching barriers. Alternatively, managers must pay particular attention to time category when time is directly involved in customer exit behavior. Therefore, online (or mobile) platforms must be configured in ways that optimize benefits and make the consumer experience time efficiency as much as possible. Conducting on-going surveys of consumers to assess their perceptions of time and modifying/improving areas perceived to be deficient could be strategies that would reduce the probability of consumers' leaving the relationship.

Finally, most online travel firms run security programs and require unnecessary announcements requesting information updates to provide personalized experiences for their customers using Bot services. However, managing Bot services should be particularly limited in the context of upkeep loss when customers no longer want a particular relationship. For example, most online travel agencies (OTA) such as expedia.com and priceline.com use Bot services to provide optimum travel services and booking confirmation, but these services often undermine customer relationships. From an online travel firm perspective, positive effects should be maximized and negative effects should be reduced through the effective management of Bot traffics.

Research Limitations and Further Research Directions

Although this study provides valuable contributions to theory and practice, it has some limitations that potential future research can address. The data were collected in South Korea, a culture high on relationship orientation. In order to improve the efficacy of the findings, future research should attempt to replicate our findings from data generated in a culture very different from that of South Korea. Research shows, for instance, that the culture of the United States or many European countries would be very different from that of South Korea on Hofstede's six dimensions (Hofstede et al., 2010). Thus, replicating our results using samples from those cultures would be a fruitful area for further research.

Similarly, another useful area for future research would be to collect consumer data during or immediately after an online visit and/or purchase. Such data would allow a deeper understanding of specific factors that can potentially affect the relationship and, as such, shed more light on our results.

In the survey carried out in this study, respondents answered questions based on their favorite travel website experiences, in which all the respondents indicated the travel websites they use most. This would be a source of heterogeneity responses if they were referring to different websites. To overcome this heterogeneity problem, we recommend exploring further studies to compare a single source (e.g., a particular website like Expedia.com) and multiple sources (e.g., hotels.com, trivago.com, lastminute.com, etc.).

Finally, we measured gender as a control variable; however, there might be other critical variables that considered the previous level of loyalty (Helgesen, 2006) and quality of the relationship (Storbacka et al., 1994) between the respondent and the company. This could play a moderating role. For example, high loyal customers might display different results from low loyal customers. On the other hand, the relationship between low loyal customers might be lower than high loyal customers. Further research is required to explore these important variables when expanding the level of relationship termination.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PH, and H-YH conceived the study. H-YH contributed data collection and wrote a first draft. PH analyzed the data and provided research insights.

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APPENDIX

Measurement Scales and Factor Loadings

Construct/item	Loadings
Upkeep loss (α = 0.758, AVE = 0.570, CR = 0.930)	
There is the periodic requirement to change my password.	0.736
There are too many security programs.	0.754
There are unnecessary announcements requesting information updates.	0.763
I am repulsed by requiring prior consent.	0.768
Time loss (α = 0.747, AVE = 0.524, CR = 0.894)	
Joining as a member is going to be a long haul.	0.703
Finding a suitable travel product requires considerable time.	0.656
After entering a search term, most information results have no relevance.	0.762
When I shop on the travel website (or mobile application), the purchasing process is very complicated.	0.769
Benefit loss (α = 0.807, AVE = 0.533, CR = 0.973)	
The purchase requirements to achieve benefits are too high.	0.741
The benefits are insufficiently attractive to encourage me to seek a relationship.	0.742
Most benefits are unrelated to my interests.	0.699
I am uncertain how many benefits are there for spending money at the travel website.	0.708
The range of benefits is limited.	0.760
Personal loss (α = 0.831, AVE = 0.594, CR = 0.959)	
When I shop at the travel website, I have some anxiety about my personal information being exposed.	0.737
When I shop at the travel website, my big concern is the privacy issue.	0.778
The travel website makes me anxious because the purchasing process is oversimplified.	0.761
When I shop at the travel website, I have doubts about its technical stability.	0.806
Relationship termination (α = 0.817, AVE = 0.604, CR = 0.952)	
I will occasionally consider ending my relationship with the travel website.	0.721
I am actively looking for a replacement travel website.	0.821
I am unlikely to continue my relationship with the travel website.	0.786
Hedonic/utilitarian motivations (α = 0.703, AVE = 0.508, CR = 0.933)	
I accomplished only what I wanted to on this travel website visit (U).	0.714
While visiting, I just found the item(s) for which I was looking (U).	0.747
Mobile shopping satisfies my sense of curiosity (H).	0.680
I like to shop for the novelty of it (H).	0.709
Switching costs (α = 0.747, AVE = 0.606, CR = 0.905)	
It takes me a great deal of time and effort to get used to a new travel website.	0.737
It costs me too much to switch to another travel website.	0.880
In general, switching to another travel website would be a hassle.	0.711

(U) indicates the utilitarian-focused item and (H) indicates the hedonic-focused item.

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Attachment Styles and Communication of Displeasing Truths

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This work explores how humans manage the communication of a displeasing and face-threatening truth and how the communicative strategies of the sender and the reaction of the receiver are influenced by their attachment style. Two experimental studies demonstrate that the attachment styles of both senders and receivers can influence the communicative styles of the sender, the emotions that both senders and receivers feel or attribute to their interlocutor, and the reactions of the receivers. In Study 1, couples of participants played a bogus computer game, ostensibly to test their abilities. Subsequently, "the spokesperson" was given the task to communicate to the "the receiver" a bogus low score of the other and a high score of oneself. Finally, all participants completed an adult Attachment Style Questionnaire (ASQ). A content analysis of the verbal messages of the spokespersons showed two main communication styles: frankness and mitigation. The results suggest that the spokespersons' attachment style influences these communication styles. Using a similar procedure, Study 2 showed that spokespersons with a high avoidant attachment more frequently used frankness when communicating low scores to the receivers. Furthermore, the emotions and impressions reported by anxious and avoidant spokespersons and receivers, respectively, confirm the negative model of the self or the other, typical, respectively, in anxious and avoidant attachment. The detection of communicative strategies stemming from different attachment styles might be of use in user modeling and the planning of personalized systems.

Keywords: attachment styles, truthful communication, displeasing truth, frankness, mitigation, politeness

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INTRODUCTION

Acquiring beliefs about the external world and themselves is a primary need for humans to achieve their goals; this is why communication – and specifically, telling the truth – is generally considered as an act of cooperation (Grice, 1975) and reciprocal altruism (Castelfranchi and Poggi, 1998), whereas deceiving, i.e., providing false or withholding true information, is viewed as a sin by religions and a harmful and morally execrable action by ethics (Bok, 1978; Augustinus, 1994; Kant, 1996). If pragmatics (Grice, 1975; Sperber and Wilson, 1995; Castelfranchi and Poggi, 1998) considers telling the truth as the main principle of communication, according to psychological studies, most people believe that this is the norm in most human interactions (Moghaddam, 2002; Levine, 2014): they expect to be believed and at the same time do not doubt the veracity of the information received (Kalbfleisch and Docan-Morgan, 2019); this facilitates social interaction and the understanding of others (Kalbfleisch and Docan-Morgan, 2019), producing indisputable beneficial effects, in terms of trust, well-being, and security.

Yet, although true beliefs are generally of help for people, sometimes they may hurt, since they may cause painful emotions, from fear to worry to anxiety, from disappointment to guilt to shame.

Therefore, people often refrain from telling displeasing truths to others (Moreno et al., 2016; Levine and Cohen, 2018); although sincerity is a feature of the utmost importance for interpersonal judgment (Anderson, 1968; Goodwin et al., 2014), it can also be viewed as an act of cruelty (Tagliapietra, 2003), while with holding unpleasant information is seen as a way to protect the other from disrupting emotions.

When a sincere answer might be unpleasant for the other or themselves (Levine and Cohen, 2018), people must decide whether and how to communicate negative news or criticism (Stone et al., 2010), and due to anxiety or social unease (Molinsky and Margolis, 2005; Margolis and Molinsky, 2008), they may not be sincere, rather simply being pleasant to build quiet social relationships (Rosen and Tesser, 1970; Tesser et al., 1971; Lee, 1993). This is the bulk of "white lies," which sometimes stem out of selfish aims but are often motivated by altruistic and pro-social goals (Castelfranchi and Poggi, 1998; Erat and Gneezy, 2012; Biziou-van-Pol et al., 2015).

Within the displeasing beliefs one may decide to withhold from an interlocutor, two main types can be distinguished, according to the negative emotions they may induce: it is not the same to conceal to a patient she has a terminal cancer and to tell a writer her novel cannot be published because it is boring. The former may induce stress or terror; the latter challenges the very image of the person. Among "white lies," we can count both disappointing, scaring, or worrying news of the former type and face-threatening ones; within these last is politeness, viewed in the psychological literature (Axia, 1999) as the ability to predict and prevent any possible discomfort of the other, protecting his/her need to be free and autonomous and his/her self-esteem and emotions, and by pragmatic studies (Lakoff, 1973; Brown and Levinson, 1978; Leech, 1983) as the set of linguistic strategies aimed at saving the interlocutor's "face" (Goffman, 1963, 1981), the image that individuals show of themselves during interactions with others. Two strategies to maintain comfortable interactions, while not directly providing true information, are *equivocation* and *avoidance* (Kalbfleisch and Docan-Morgan, 2019), i.e., providing information that can be interpreted in various ways or shifting to other topics. In other cases, one does not tell the exact truth, because one thinks the other does not really want to know it.

In sum, conveying a displeasing truth to others may trigger unpleasant emotions in the sender as much as in the receiver (Poggi and D'Errico, 2010, 2018). Here it is relevant whether the sender is empathic toward the receiver, and this is mediated by his/her attitude toward and relationship with the other, which may depend in turn on some individual characteristics of the sender, including his/her attachment style. This article presents two studies aimed at exploring the relationships between attachment styles of senders and receivers and their ways to tell and to react to a displeasing truth.

Attachment theory conceptualizes "the propensity of human beings to make strong affectional bonds to particular others" (Bowlby, 1977, p. 201). The attachment system develops in childhood: infants seek proximity with their caregivers, especially in conditions of danger or threat. Children, over time, internalize their early attachment relationships, and their experience with caregivers finally forms a prototype (*internal working model of attachment*) for adult relationships (Bowlby, 1973, 1982; Holmes, 1993; Meyer and Pilkonis, 2001) that remains active throughout the life span (Bowlby, 1977). Three main adult attachment styles have been identified (e.g., Hazan and Shaver, 1987; Kobak and Sceery, 1988; West and Sheldon, 1988):

1. Secure attachment that represents a positive model of the self and security of relationships (Mikulincer and Shaver, 2016). Secure individuals have a sense of worthiness (lovability) plus an expectation that other people are generally accepting and responsive;
2. Anxious attachment that represents a negative model of the self and relational anxiety (Bartholomew and Horowitz, 1991). Anxious individuals have a sense of unworthiness (unlovability) combined with a positive evaluation of others and a need for acceptance of valued others;
3. Avoidant attachment that represents a negative model of the other and avoidance of relationships (Bartholomew and Horowitz, 1991). Avoidant individuals have a sense of love-worthiness combined with a negative disposition toward other people and a need to protect themselves against disappointment by avoiding close relationships and maintaining a sense of independence and invulnerability.

Since different attachment styles – secure, anxious, and avoidant – result in different relationships with the other, this work investigates if different attachment styles affect the ways in which people convey a displeasing truth, more specifically evaluative information concerning the receiver that may hurt his/her face and hence trigger emotions of shame, humiliation, and embarrassment.

Actually, to the best of our knowledge, there is no specific research devoted to this topic. Some studies investigate how attachment relates to the self-assessed habit of lying (Cole, 2001; Ennis et al., 2008; Gillath et al., 2010), but they do not directly observe the actual deceptive communication of people with secure or insecure attachment styles. Moreover, from a methodological point of view, self-report measures are commonly used to study deception, but the use of such self-assessed evaluations has been criticized because, for reasons of social desirability, participants' self-assessments may be distorted (Elaad et al., 2012); to overcome the limitations of self-report measures, a new methodological approach is needed (Leone et al., 2016; Migliorisi, 2019). The goal of our research is therefore to assess the relationship between attachment style and the communication of a displeasing truth, by observing how people with secure or insecure attachment styles actually cope with the experimental task of telling negative evaluative information to a receiver they did not formerly know.

In the following, we present two studies investigating this topic.

STUDY 1

Aims

The goal of the first study was to observe how people communicate some face-threatening news to others and to establish whether their style of communicating such displeasing truth is in some way related to their attachment style.

Procedure

Considering that traditional self-report methods do not allow a reliable assessment of people's sincerity (DePaulo et al., 2003; Sporer and Schwandt, 2007), a novel and quite complex procedure has been put in place in order to observe people in a real situation in which (1) they had to decide how much and how to tell when telling another a face-threatening truth and (2) there was also the chance to video-record and analyze real interactions. To carry out such procedure, we recruited 68 participants among undergraduate students of Social Psychology and coupled them into 34 pairs. A *cover story* was used asking them to participate in marketing research on the consumption of cultural products among young people, proposed by a marketing company independent from the university. The two participants in each pair (previously unknown to each other) were invited through an email message from the fictitious marketing company informing them that the research comprised playing a game in pairs and that the winning pair would receive a €200 voucher to spend in a store with media products (books, music CDs, video movies, and TV series). It was specified that the other pairs would also receive €20 voucher to spend in the same store. The participants were told that the research consisted of two phases. First, they would go to the department where the research should have taken place and meet with an unknown participant with whom the experimenter had paired them. Second, a few days later and during class, they would complete a short questionnaire and receive information about the study.

Phase I

During the first phase, both members of the pair were informed that before competing against the other pairs, each member would individually play a computer game to test his/her previous skills. They were also told that based on the results of this test, the pair could decide whether to participate in the playful competition with the other pairs. Furthermore, the participants were told that in the second phase of the procedure, they would complete a questionnaire (the ASQ, Attachment Style Questionnaire). Subsequently, they were asked to sign an informed consent form. This first consent form, right for research purposes, did not communicate that some participants would be videotaped during the first phase.

Setting

The pair was invited to sit in a room with two chairs, one in front of the other, separated by a table with only a computer set in front of one of the chairs. A hidden camera was placed in front of it on a piece of furniture. The pair would meet in this room before and after individually playing the computer game. After signing the consent form, each member of the pair was assigned a numeric code, and the experimenter told them to write it down on the questionnaire to be completed during the second phase of the procedure. Actually, this was a ploy to allow the experimenter to match the video recordings grabbed in the first phase of the procedure with the questionnaires to be administered in the second phase.

In each pair, one member, always the participant who randomly sat in the direction of the hidden camera, was chosen by the experimenter as a spokesperson. The spokesperson always received a code with an odd number, so it was possible to discriminate, among all participants, those who had played the role of spokesperson. As anticipated in the consent form, the members of the pair were reminded that they would perform a computer task in different rooms to assess their own individual skills before competition. The participants were told that a central computer would monitor their game actions in real time and process their results immediately after the test. Starting from these results, the pair could decide whether to participate together against the other pairs. The researcher specified that the pairs who chose not to participate in the game with the other pairs could still complete the questionnaire (ASQ scale) during the second part of the procedure. Finally, the researcher told the two members that she would communicate both scores only to the spokesperson and that the spokesperson would communicate the received score to the other participant. After listening to these instructions, the spokesperson was left alone in the room while the other participant was accompanied to another room. The two participants individually played the computer game in different rooms. After 7 min, the two participants were interrupted. The experimenter told the spokesperson that the average score obtained in the execution of the test was 6.2 (on a scale of 0–10). The spokesperson was informed that he/she had a high score (i.e., 8.4), while his/her partner had a very low one (i.e., 3.6). Furthermore, the experimenter pointed out to the spokesperson that the difference between the individual skills assessed by the difference between these two (bogus) scores would have penalized the pair in the competition with other pairs. The researcher also reminded the spokesperson to communicate the outcome of the test to his/her partner. For this reason, the other participant was accompanied to the room where the spokesperson was waiting for him/her. The pair had 3 min to decide whether to participate in the game against the other pairs. In this way, the spokesperson was obliged to communicate the very low score to the other participant. This bogus assessment of the individual skill that the spokesperson was expected to communicate to the other participant was the way in which a displeasing truth was introduced the procedure. Due to this methodological choice, when communicating to the other member of their couple the difference between their two bogus scores participants acted as if the content of their communication was true. This is a kind of procedure that, transiently resembling to the scenario of a game simulation, may be particularly apt for observing difficult interpersonal interactions (Leone, 2013). After 3 min, the participants had to communicate their decision, and they were reminded of the appointment for the second phase of the procedure. Therefore, in this procedure, the unpleasant truth was a low score obtained in a computer game. This truth was made

particularly unpleasant to communicate and to receive because it encouraged a social comparison between the two participants. In fact, one of the two participants had not only a lower score than the average but also a lower score than his/her partner.

Phase II

After a few days, during a class, the ASQ by Feeney et al. (1994) was administered to the participants. It asked the participants to rate (on a six-point scale) the extent to which each item described their feelings and behavior in interpersonal relationships (not necessarily romantic). Subsequently, the participants were subjected to debriefing, where the true research purposes were revealed. The researcher provided a detailed explanation of the procedure, including the fact that the playful competition would not have occurred. Finally, the students were told they had been videotaped during the first phase of the research, and in accordance with the ethical requirements of research on studies requiring a cover story, they signed a second consent form for the video recordings. They were assured that in case of non-authorization, they would receive the promised reward for their participation and that the video recordings would be irreversibly destroyed.

Participants

Thirty-four pairs of undergraduate students participated in the research. This first study focused on the observation of the spokesperson's communication. Therefore, the results of this first study refer only to the 34 participants (24 women and 10 men, mean age of 20) who played the role of the spokesperson.

Analysis

The Communication of the Displeasing Truth

In this study, the unpleasant truth that the spokesperson had to communicate to the other participant consisted of a low score obtained in a computer game. This score was lower than both the average and also the score obtained by the spokesperson. The parts of the video recordings in which the spokespersons – who authorized use of the video recording – communicated the unpleasant truth to the other participant were selected and transcribed. In order to identify the communication styles of the spokespersons, a qualitative analysis of their verbal content was performed.

The Spokespersons' Communication Styles

The corpus of interactions between spokespersons and their partners is of 4,974 words, for a total of 102 min. A qualitative analysis was carried out of the verbal content of the interaction by two judges independently, achieving a good level of agreement (k = 0.88), from which two main communication styles of the spokespersons emerged: *straight* and *mitigated*. By relying on previous definitions by Caffi (1999), we define mitigation as any linguistic and pragmatic strategy used by the sender of a communicative act aimed at attenuating the potential negative emotions caused to the addressee by that communicative act. In pragmatic and linguistic literature, typical examples of mitigation are indirect acts and justification moves, passive and impersonal constructions, modal adverbs, and parenthetical forms (Caffi, 2007), but the mitigation forms we consider here are general discourse strategies aimed at attenuating the addressee's displeasure for the displeasing truth conveyed.

The spokespersons who chose a *straight* communication style communicated the unpleasant truth to the other participant without adding anything else. By contrast, the spokespersons who chose a mitigated communication style conveyed the unpleasant truth to the other participant while adding other statements, among which we can distinguish five subtypes:

- Reassuring the partner (for example, "*don't worry*");
- Emphasizing the difficulty of the game ("*the game wasn't easy*"; "*the last items were very difficult*");
- Showing surprise at one's own score and/or underestimating one's own capacities ("*even though I have no logical skills, strangely.*"; "*I didn't even finish the game*");
- Attributing to the researcher some words that she had not actually said ("*the researcher told me that our average score is 6.2*");
- Consulting with the partner on the game ("*how would you have responded this item?*").

The Spokespersons' Attachment Style

The ASQ is a self-report and dimensional measurement of adult attachment. The ASQ was chosen because this kind of self-report measure is recommended and has adequate reliability and very good face and discriminant validity, when attachment is not a primary area of investigation (Ravitz et al., 2010). Furthermore, a dimensional questionnaire was chosen because this kind of measures does not assign individuals to categories of attachment style, but it assesses the degree to which various dimensions of attachment are present. In fact, categorical measures of attachment have been criticized theoretically, for assuming that differences among people within a category are "unimportant or do not exist" (Mikulincer and Shaver, 2007, p. 85), and analytically, for their limited statistical power compared with dimensional measures (Fraley and Shaver, 2000).

The 40 items on the ASQ include five subscales:

1. Confidence in self and others (for example, "*overall, I am a worthwhile person*"; "*I feel confident that other people will be there for me when I need them*");
2. Discomfort with closeness ("*while I want to get close to others, I feel uneasy about it*");
3. Need for approval and confirmation by others ("*I find it hard to make a decision unless I know what other people think*");
4. Concern about relationships ("*I worry that others won't care about me as much as I care about them*");
5. Viewing relationships as secondary to achievement in various domains, such as school or career ("*achieving things is more important than building relationships*").

In the above subscales, no. 2, discomfort with closeness, and no. 5, viewing relationships as secondary, are clearly conceptually related to avoidant attachment (Bartholomew, 1990; Collins and Read, 1990; Brennan et al., 1998; Mikulincer and Shaver, 2003, 2007). No. 4, concern about relationships, and no. 3, need for approval and confirmation by others, are conceptually related

to anxious attachment (Hazan and Shaver, 1987; Bartholomew, 1990; Bartholomew and Horowitz, 1991). No. 1, confidence (in self and others), is related to secure attachment (Mikulincer and Shaver, 2007). In addition to yielding the above five scores, ASQ items can be used to form scores for propensity of attachment anxiety and avoidant attachment. In this study, the median value within each subscale was calculated, and the participants were classified based on their scores being above or below this median value. Therefore, dichotomous variables were obtained for each dimension measured by the ASQ.

Results

The content analysis of the spokespersons' verbal communication showed that they chose different communication styles to convey an unpleasant truth. In the 34 spokespersons, 16 chose a straight communication style (47%), while 18 utilized a mitigated communication style (53%). Therefore, we investigated whether there was a relationship between these communication styles and the spokespersons' attachment styles. The chi-square test indicated that, among the spokespersons with "high need for approval and confirmation by others" (median value = 3) sub-group (n = 16), 75% of them (n = 12) chose the mitigated communication style, while only 25% chose a straight communication style ($\chi^2 = 5.903$; $p = 0.02$).

Discussion and Conclusion

This first exploratory study produced interesting results. First, from the analysis of the verbal content expressed by the spokespersons, two different communication styles emerged: straight and mitigated. Furthermore, there was a relationship between the mitigated communication style and the dichotomous variable "high need for approval and confirmation by others."

The need for approval and confirmation by others reflects anxious attachment that represents a negative model of the self (Bartholomew and Horowitz, 1991) and includes concerns about intimacy, jealousy, and fear of abandonment, as well as a dependency on a close other's approval rather than an internal sense of self-worth (Brennan et al., 1998; Cole, 2001). Therefore, one might assume that people with these characteristics have more difficulty communicating an unpleasant truth and that they choose a mitigated communication style to reduce their relational anxiety. In fact, the spokespersons who chose a mitigated communication style reassured the other participant, emphasized the difficulty of the game, showed surprise at their own score, and underestimated their own capacities. Further, they attributed to the researcher some words that she had not said, and they consulted with the other participant on the game. Consistent with the definition of mitigation (Caffi, 2007), by adopting these strategies, the spokespersons modulated their communication in the direction of a mitigation to avoid potentially unpleaseant perlocutionary outcomes. Interestingly enough, this communication strategy resembles to over-helping strategies (Leone, 2012), i.e., interactions when helpers, because of their high level of anxiety due to their perception of the recipients' vulnerability, give them a kind of help exceeding their actual needs. Similar results were shown, for instance, when mothers interacted in a game simulation with their chronically ill children (D'Errico and Leone, 2006), or when teachers interacted in a similar game simulation with pupils of immigrant families (D'Errico et al., 2010).

The results of this first study are encouraging because they suggest that the spokespersons' attachment style influences the communication style they adopt when conveying a displeasing truth. However, this study only focused on the spokesperson's communication: the reactions of the participants who received a displeasing truth were not observed. In any case, this study also aimed to test a new procedure, never previously used; since this procedure proved to be effective, a second more articulated study was carried out, to consider also the participants who received the displeasing truth and to provide a more fine-grained analysis of the communication of both the spokesperson and the receiver.

STUDY 2

Research Questions

Study 1 gave us some first evidence that the communication styles adopted by individuals in communicating a displeasing truth are influenced by the individuals' attachment styles. However, from this first study, it was not clear if people with different attachment styles feel different kinds of emotions about communicating a displeasing truth to another or if they attribute different emotions to their interlocutors. Furthermore, other questions were left unsolved: How do the receivers take the displeasing truth? What are the emotions they feel, and are these emotions in some way affected by their attachment style?

To go in-depth on these issues, we performed a second study to investigate:

1. The effect of the propensity for the different attachment styles on distinct ways of communicating a displeasing truth;
2. The effect of the spokespersons' attachment styles on the emotions felt and those attributed to their interlocutor.

Furthermore, while the first study only focused on the participant communicating the displeasing truth (spokesperson), this second study also considered the participant who received the displeasing truth (receiver). Therefore, we further investigated:

3. The effect of the receivers' attachment styles on the emotions they felt and those they attributed to the spokespersons.

In order to investigate these aspects, the experimental procedure was slightly modified.

Experimental Design

Like in the first study, the independent variables were the spokesperson's and receiver's propensity for attachment, namely secure, avoidant, or anxious. However, in the second study, more dependent variables were considered, namely:

A. The way in which the spokesperson communicated the low score to the receiver;

B. The spokesperson's reactions, namely:
   a. Emotions about his/her high score and the receiver's low score;
   b. Emotions attributed to the receiver;
   c. Emotions the spokesperson would have felt if he/she had been in the place of the receiver;
   d. How the spokesperson perceived the receiver during the communication of the displeasing truth;

C. The receiver's reactions, namely:
   a. Emotions about his/her own low score and the spokesperson's high score;
   b. Emotions he/she would have felt if he/she had been in the place of the spokesperson;
   c. How the receiver perceived the spokesperson during the communication of the displeasing truth.

Materials and Methods

Procedure

This study used the same procedure described for Study 1, but in order to investigate the multiple dependent variables above, the experimental procedure was slightly modified. Two new questionnaires were introduced. Like in the procedure already used in Study 1, the participants (previously unknown to each other) were divided to form pairs. Each participant individually played a bogus computer game, ostensibly to test his/her previous abilities. Subsequently, one participant (the spokesperson) was randomly given the task to communicate to the other one (the receiver) the bogus low score obtained in the computer game (displeasing truth). Three minutes was given to the pair to decide whether to participate in the game together with the other pairs, so the spokesperson was put in the position of communicating the very low score to the other participant. Differently from Study 1, after this confrontation between spokesperson and receiver, a questionnaire was administered to both, presenting a list of six emotions: disappointed, proud, embarrassed, guilty, satisfied, and surprised. The participants were asked to rate (on a six-point scale) the extent to which they had felt each emotion when coming to know their score and (again on a six-point scale) the extent to which they had felt the same six emotions when knowing the score obtained by their partner. After completing the questionnaire, the participants were reminded of the appointment for the second part of the procedure.

Similar to the first study, also during the second phase of the procedure of Study 2, all participants completed the ASQ. Before the ASQ, however, the participants of Study 2 were administered a new questionnaire. The questionnaire first reminded them that the average score obtained in their performance of the computer game was 6.2 (on a scale of 0–10). It then asked the participants to indicate whether their own score was higher or lower than the average and if the score obtained by their partner was higher or lower than the average (control questions on the participants' scores). Like in the first study, the spokespersons had a high score, while the receivers had a very low score – the received displeasing truth. After this task, a list of 11 emotions was presented: angry, disappointed, sorry, happy, proud, embarrassed, guilty, in distress, worried, quiet, and sad. The participants were asked to rate (on a six-point scale) the extent to which they would have felt each emotion if they were in the place of the other participant. Finally, a list of 25 adjectives was presented: uncomfortable, welcoming, friendly, angry, cooperative, disappointed, sorry, happy, proud, cold, embarrassed, awkward, guilty, in distress, encouraging, irritated, confused, worried, reassuring, blunt, strict, safe, surprised, quiet, and sad. Here, the participants were asked to rate (on a six-point scale) the extent to which they attributed each adjective to the other participant during the face-to-face confrontation. Finally, after administering the questionnaires, the researcher debriefed the participants.

Participants

Forty-five pairs of undergraduate students participated in the study. While the first study only focused on the participants who had played the role of spokespersons, this second study also considered their partners, the receivers. Therefore, the results of this study refer to 45 spokespersons and 44 receivers (1 receiver did not participate in the second phase of the procedure). All in all, there were 89 participants (59 women and 30 men, mean age 20.6).

Qualitative Analysis of the Spokespersons' Communication

In the first study, a dichotomous classification of the communication styles of the spokespersons (the straight or mitigated communication style) was performed. In this second study, our analysis allowed us to provide a finer distinction.

The transcription of the interactions within the 45 pairs results in a corpus of 11,058 words, a total of 135 min. To elaborate a set of categories for the analysis, first an informal overview was performed of the whole corpus, from which some recurrent communication strategies of the spokespersons emerged. When these categories were found to be exhaustive, 226 utterances in the corpus were classified in terms of them by two judges independently, achieving a good level of agreement ($k = 0.89$).

As compared to what was found in Study 1, results from the more in-depth qualitative analysis conducted in Study 2 allowed us to find three main macro-categories of communicative strategies used when conveying a displeasing truth: reticence, mitigation, and frankness. Moreover, each macro-category showed sub-categories, allowing us to catch nuances of the communication of an unpleasant truth that added complexity to the simpler description of Study 1.

Reticence

The spokespersons who choose a reticent communication style try to avoid communicating the displeasing truth to the other participant. There are two signals of reticence:

> *Delegation*: While talking to the receiver, the spokesperson attempts to delegate the communication of the displeasing truth to the researcher ("*Did the researcher tell you your score?*");
> *Doubt*: The spokesperson shows doubts about his/her role and the task assigned by the researcher of communicating the score to the receiver ("*I don't know if I can tell you the results.*").

Both these signals represent the spokesperson's attempt to evade the task of communicating the displeasing truth to the other participant.

Mitigation

For the mitigated communication style, we observed five types:

> *Similarity*: The spokesperson claims his/her similarity with the receiver ("*even I didn't complete the game*");
> *Minimization*: The spokesperson attenuates the importance of the game ("*the scores are irrelevant*");
> *Solidarity*: The spokesperson shows awareness that he/she is communicating a displeasing truth to the receiver ("*unfortunately, you got 3*");
> *Uncertainty*: The spokesperson shows uncertainty about the information he/she is communicating to the receiver ("*you got 3, I think*"), or he/she expresses disbelief at the researcher's words ("*I don't believe what the researcher told me*");
> *Lie*: The receiver asks the spokesperson if he/she performed the game incorrectly, and the spokesperson denies ("*Noooo. . .the researcher told me two results that I don't think are true*").

These strategies are aimed to mitigate the potentially displeasing impact of the news.

Frankness

Within the frank communication style, we observed four types:

> *Receiver's fault*: The spokesperson assigns the responsibility for the minimal chance of winning in the playful competition with the other pairs to the receiver ("*We are way behind because you got a low score.*");
> *Game simplicity*: The spokesperson shows surprise and confusion about the receiver's low score. By doing so, he/she risks reinforcing the receiver's self-attribution of failure ("*It's impossible to fail in this game.*");
> *Own skill*: The spokesperson emphasizes one's own skill in the game and thus risks underlining the difference between own score and the receiver's ("*I didn't know that the time to play was limited, but still I was fast.*");
> *Extreme frankness*: The spokesperson communicates with very frank expressions, often combined with laughter ("*You sucked.*").

The signals of frankness, as opposed to those of mitigation, might even amplify the potentially displeasing impact of the news. Our hypothesis was that the spokespersons who choose these extremely frank expressions have difficulty imagining the possible discomfort of the receivers about their own low score, which was both lower than the average and lower than the score obtained by the spokesperson. For each spokesperson, the frequencies of each communicative strategy (reticence, mitigation, or frankness) were calculated.

Hypotheses

Based on the working model of secure, avoidant, and anxious attachment, as well as on the analysis of the spokesperson's three possible communication styles, frank, mitigated, and reticent, the following predictions were made:

1. Both spokespersons with secure and avoidant attachment would choose frank communication;
2. Spokespersons with anxious attachment would choose mitigated and reticent communication.

Regarding the spokesperson's and the receiver's reactions, we predicted that the participant's self-assessed emotions and perceptions would be consistent with the characteristics of the internal working model of each attachment style:

1. For individuals with secure attachment, emotions typical of *positive self-image* (the self as worthy of love and support), such as pride and satisfaction, and reactions linked to *positive image of the others* (other people seen as trustworthy and available), such as perception of the other as friendly;
2. For those with anxious attachment, emotions and perception linked to a *negative self-image and high dependency* (a positive self-regard requires external validation or can only be maintained by others' ongoing acceptance), e.g., disappointment at one's high score and guilt or embarrassment for the receiver's low score, and perception of the other as angry and cold;
3. For those with avoidant attachment, reactions stemming from *low dependency and high avoidance of intimacy* (people avoid close contact with others as a result of their expectations of aversive consequences), e.g., pride and satisfaction about their high score, and perception of the receiver as uncooperative and unwelcoming.

Quantitative Analysis

First, the answers to the control questions about participants' scores were verified. We found that the spokespersons understood that their score was higher than the average and that the receivers understood that their score was lower than the average. This result confirms the validity of the procedure. Since in Study 2, more participants filled in the ASQ, it was possible to calculate the scores of the propensity for secure, avoidant, or anxious attachment, by performing a factor analysis.

Regarding the "propensity for secure attachment," the factorial analysis (items 1, 2, 3, 19, 31, 33 reversed, 37, and 38) explained 31.61% of the variance. All of the factor scores were above.42, except item 2, which was removed from the calculations.

Regarding the "propensity for anxious attachment," the factorial analysis (items 11, 13, 15, 18, 22, 24, 27, 29, 30, 31 reversed, 33, and 38 reversed) explained 35.16% of the variance. All of the factor scores were above.38, except items 11, 29, and 31 reversed.

Regarding the "propensity for avoidant attachment," the factorial analysis (items 3 reversed, 5, 8, 9, 10, 14, 16, 17, 19 reversed, 20 reversed, 21 reversed, 23, 25, 34, and 37 reversed) explained 25.72% of the variance. All of the factor scores were above.33, except items 8, 9, 10, 23, 25, and 37 reversed.

Furthermore, Cronbach's alpha was measured for each attachment. The values were 0.83 for the propensity for anxious

attachment, 0.77 for the propensity for avoidant attachment, and 0.62 for the propensity for secure attachment.

To explore the effect of the spokesperson's propensity toward secure, anxious, or avoidant attachment on his/her communication style, his/her emotions and perceptions, and the effect of the receiver's propensity for secure, anxious, or avoidant attachment on his/her emotions and perceptions, the participants were distinguished into high and low compared to the average of the items for each propensity for attachment (3.70 for the propensity for secure attachment; 3.20 for the propensity for anxious attachment; and 3.87 for the propensity for avoidant attachment). Using this method, we obtained three independent variables for the spokesperson and three independent variables for the receiver.

Results

This section overviews the results of Study 2, first with regard to the dependent variables connected to the spokesperson, followed by those concerning the receiver.

Results Concerning the Spokespersons

The Spokesperson's Communication Style

To explore the effect on the communication style (reticence, frankness, or mitigation) of the spokespersons with high vs. low secure, anxious, and avoidant attachment, we performed analyses of variance (ANOVAs). The first two analyses did not produce significant results. On the contrary, the third ANOVA showed that high avoidant spokespersons [mean (M) = 1.92; standard deviation (SD) = 1.44] chose franker communication [$F(1, 44) = 3.93$; $p < 0.05$; $n^2 = 0.084$] compared to low avoidant ones ($M = 1.10$; $SD = 1.20$) (**Figure 1**).

We performed an ANOVA for each of the effects investigated.

The Spokesperson's Emotions About His/Her Own High Score

The ANOVA exploring the effect of the spokesperson's propensity for anxious attachment (high/low) on the emotions felt about his/her high score showed that the highly anxious spokespersons ($M = 0.46$; $SD = 0.83$) felt more embarrassed about their high score [$F(1, 44) = 3.57$; $p < 0.065$; $n^2 = 0.077$] than low anxious ones ($M = 0.10$; $SD = 0.3$).

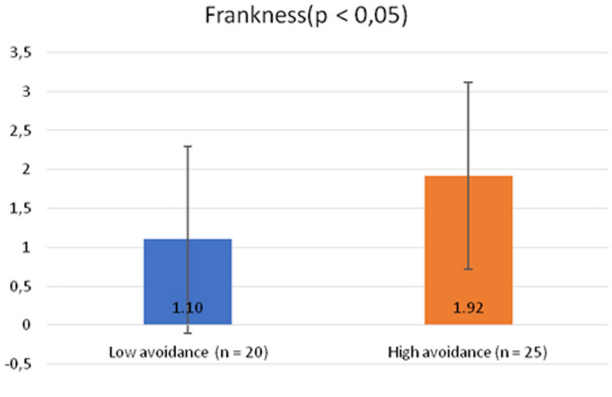

FIGURE 1 | The effect of the spokesperson's avoidant attachment (high vs. low) on his/her communication style (reticence, frankness, or mitigation).

The Spokesperson's Emotions If He/She Had Been in the Place of the Receiver

Concerning the effect of the spokesperson's anxious attachment on the emotions he/she would have felt if he/she had been in the place of the receiver, the ANOVA showed that the spokespersons with high anxious attachment would have felt sadder [$F(1, 44) = 4.64$; $p < 0.03$; $n^2 = 0.10$] and more in distress [$F(1, 44) = 5.95$; $p < 0.019$; $n^2 = 0.12$] compared to the low anxious ones (**Table 1**).

The spokespersons with high secure attachment ($M = 1.05$; $SD = 1.35$) would have felt less in distress if they had been in the place of the receiver [$F(1, 42) = 4.77$; $p < 0.035$; $n^2 = 0.10$] compared to the low secure spokespersons ($M = 1.95$; $SD = 1.36$) (**Table 1**).

Furthermore, in the spokespersons with a high propensity for avoidant attachment, there was a positive Pearson's correlation coefficient between the worry that the spokesperson would have felt, if he/she had been in the place of the receiver, and the reticent communication style ($r^2 = 0.44$; $p < 0.031$). Therefore, the highly avoidant spokespersons who chose a reticent communication style would have felt more worried if they had been in the place of the receiver.

The Spokesperson's Perception of the Receiver

The ANOVA that explored the effect of the spokespersons' attachment on their perception of the receiver showed that the high secure spokespersons ($M = 0.63$; $SD = 1.01$) perceived the receiver as less worried [$F(1, 40) = 4.02$; $p < 0.05$; $n^2 = 0.09$] during the displeasing communication compared to the low secure ones ($M = 1.41$; $SD = 1.4$) (**Table 2**).

Again, the spokespersons with a high propensity for avoidant attachment ($M = 4.5$; $SD = 0.74$) perceived the receiver as more collaborative [$F(1, 40) = 7.03$; $p < 0.01$; $n^2 = 0.15$] during the displeasing communication compared to the low avoidant spokespersons ($M = 3.68$; $SD = 1.2$) (**Table 2**).

Furthermore, there was a significant Pearson's correlation coefficient between the spokespersons' propensity for avoidant attachment, their emotions about the low score of the receiver, and their communication style. This finding indicates that the

TABLE 1 | The effects of anxious and secure attachment on the spokesperson's imagined emotions if he/she had been in the place of the receiver.

Emotions	Propensity for *anxious* attachment	Means	*SD*
	High	1.73	1.45
Sad	Low	0.9	0.99
	High	2	1.51
In distress	Low	1	1.14
Emotions	**Propensity for *secure* attachment**	**Means**	***SD***
In distress	High	1.05	1.35
	Low	1.95	1.36

Means, mean of emotions; SD, standard deviation.

TABLE 2 | The effects of the spokesperson's secure and avoidant attachment on his/her perception of the receiver.

Perception	Propensity for *secure* attachment	Means	*SD*
	High	0.63	1.01
Worried	Low	1.41	1.4
Perception	**Propensity for *avoidant* attachment**	**Means**	***SD***
Collaborative	High	4.5	0.74
	Low	3.68	1.2

Means, mean of perception.

high avoidant spokespersons who choose franker communication feel more surprised about the low score of the receiver ($r^2 = 0.45$; $p < 0.020$).

Results Concerning the Receivers

The results below refer to the participants who received the displeasing truth: their score in the computer game was lower than the average.

The Receiver's Emotions About His/Her Low Score

The ANOVA that explored the effect of the receivers' attachment on their emotions about their low score showed that the receivers with high anxious attachment felt less satisfied [$F(1, 42) = 11.79$; $p < 0.001$; $n^2 = 0.22$] and more embarrassed [$F(1, 42) = 8.11$; $p < 0.007$; $n^2 = 0.16$] about their low score compared to the low anxious receivers (**Table 3**).

On the contrary, the ANOVA showed that the high secure receivers ($M = 1.64$; $SD = 1.19$) felt more satisfied [$F(1, 42) = 5.38$; $p < 0.02$; $n^2 = 0.11$] about their low score compared to the low secure receivers ($M = 0.8$; $SD = 1.01$) (**Table 3**).

The Receiver's Emotions About the High Score of the Spokesperson

The receivers with high anxious attachment felt more embarrassed [$F(1, 40) = 20.10$; $p < 0.001$; $n^2 = 0.34$], less satisfied [$F(1, 40) = 0.76$; $p < 0.03$; $n^2 = 0.10$], more guilty [$F(1, 40) = 4.98$; $p < 0.03$; $n^2 = 0.11$], and more disappointed [$F(1, 40) = 7.09$; $p < 0.01$; $n^2 = 0.15$] about the high score of the spokesperson compared to the receivers with low anxious attachment (**Table 4**).

The Receiver's Perception of the Spokesperson

The receivers with a high propensity for anxious attachment perceived the spokesperson as more uncomfortable [$F(1, 39) = 6.30$; $p < 0.01$; $n^2 = 0.14$], less happy [$F(1, 39) = 6.06$; $p < 0.01$; $n^2 = 0.13$], more embarrassed [$F(1, 39) = 10.96$; $p < 0.002$; $n^2 = 0.22$], more in distress [$F(1, 39) = 11.68$; $p < 0.002$; $n^2 = 0.23$], and less safe [$F(1, 39) = 4.74$; $p < 0.03$; $n^2 = 0.11$] during the displeasing communication compared to the receivers with low propensity for anxious attachment (**Table 5**).

The Receiver's Imagined Emotions If He/She Had Been in the Place of the Spokesperson

The receivers with high anxious attachment ($M = 1.6$; $SD = 1.63$) would have felt more in distress [$F(1, 39) = 10.77$; $p < 0.002$; $n^2 = 0.22$] in the place of the spokesperson compared to the low anxious receivers ($M = 0.4$; $SD = 0.64$) (**Table 6**). On the contrary, the receivers with high secure attachment would have felt more quiet [$F(1, 39) = 5.52$; $p < 0.02$; $n^2 = 0.12$], more proud [$F(1, 39) = 4.60$; $p < 0.03$; $n^2 = 0.10$], and more happy [$F(1, 39) = 4.26$; $p < 0.04$; $n^2 = 0.10$] if they had been in the place of the spokesperson (**Table 6**).

TABLE 3 | The effects of anxious and secure attachment on the receiver's emotions about his/her low score.

Emotions	Propensity for *anxious* attachment	Means	*SD*
	High	0.63	0.88
Satisfied	Low	1.78	1.15
	High	2.06	1.52
Embarrassed	Low	0.81	1.30
Emotions	**Propensity for *secure* attachment**	**Means**	***SD***
	High	1.64	1.19
Satisfied	Low	0.8	1.01

Means, mean of emotions.

TABLE 4 | The effect of the receiver's anxious attachment on his/her emotions about the high score of the spokesperson.

Emotions	Propensity for *anxious* attachment	Means	*SD*
	High	2.47	1.99
Embarrassed	Low	0.46	0.85
	High	2.27	1.83
Satisfied	Low	3.35	1.32
	High	1.60	1.76
Guilty	Low	0.58	1.17
	High	1.27	1.53
Disappointed	Low	0.27	0.87

Means, mean of emotions.

Discussion

This second study allowed us to explore in greater depth how the strategies to communicate a displeasing truth are linked to attachment styles of the spokesperson and to explore receivers' reactions as well.

First of all, a more complex and nuanced description of communication strategies was found. Together with mitigation, already found in Study 1, reticence emerged as a way to cope with the negative aspects of conveying the displeasing truth. Frankness too showed not only a positive facet, linked to a collaborative attitude to present the receiver with the plain truth, but also a negative aspect of extreme frankness that disregarded receivers' feelings. Different attachment styles seemed not directly linked to the choice of a specific communication strategy, if not for the spokespersons with high avoidant attachment, who showed a tendency to choose a franker and somehow brutal communication. This result is consistent with the negative model of the other (Bartholomew and Horowitz, 1991), which characterizes avoidant attachment: a lack of trust in the other, fear of intimacy, and avoidance of closeness due to expectations

TABLE 5 | The effect of the receiver's anxious attachment on his/her perception of the spokesperson.

Perception	Propensity for anxious attachment	Means	*SD*
	High	1.53	1.24
Uncomfortable	Low	0.68	0.9
	High	1.53	1.45
Happy	Low	2.72	1.48
	High	2.07	1.58
Embarrassed	Low	0.76	0.92
	High	2.07	1.3
In distress	Low	0.8	1.00
	High	2.07	1.10
Safe	Low	2.96	1.30

Means, mean of perception.

TABLE 6 | The effects of the receiver's anxious and secure attachment on the imagined emotions if being in the place of the spokesperson.

Emotions	Propensity for *secure* attachment	Means	*SD*
	High	3.85	1.22
Quiet	Low	2.71	1.81
	High	3.42	1.41
Proud	Low	2.29	1.89
	High	3.27	1.53
Happy	Low	2.14	1.83
Emotions	**Propensity for *anxious* attachment**	**Means**	***SD***
	High	1.6	1.63
In distress	Low	0.4	0.64

Means, mean of emotions.

that others will not be available and supportive (Brennan et al., 1998; Cole, 2001). Therefore, avoidant spokespersons might choose a franker communication style because they do not care about the possible negative consequences that revealing an unpleasant truth might have on a relationship. Coherently with theoretical frameworks assuming that individuals with avoidant attachment choose strategies to increase their autonomy and distance in the relationships (Cassidy and Kobak, 1988), such a frank communication style might serve as a strategy used by avoidant individuals to keep everyone out, sending signals that discourage the search for emotional closeness in others.

Being contemptuous of others – a characteristic of individuals with avoidant attachment – might also explain why spokespersons with high avoidant attachment who chose a frank communication style felt more surprised about the low score of the receiver. Probably they thought the game was easy to play, and their surprise might include a negative evaluation of the receiver's performance. This might support the interpretation that the avoidant spokespersons choose a frank communication style as an indication of their low evaluation of the receiver and a means to keep a distance from others. Apart from this direct link of the avoidant attachment to franker communication of the displeasing truth, all other effects of attachment styles shown in the study are linked to the perceptions and emotions felt by both spokespersons and receivers during this difficult communication. More precisely, we may consider these effects in accordance with the different attachment styles of both spokespersons and receivers. In fact, being involved in the communication of a displeasing truth is a difficult personal and social condition that could activate the attachment system of the spokesperson and of the receiver and mold their perceptions and emotions during this challenging interaction according to their own specific internal working models.

The results of Study 2, which not only observed actual communications of the spokesperson but also explored perceptions and emotions of both spokespersons and receivers, can therefore be grouped according to their attachment styles.

Perceptions and Emotions of Avoidant Spokespersons

Spokespersons with high avoidant attachment perceive the receiver as more collaborative during the unpleasant communication compared to those with low avoidant attachment. One can argue that the highly avoidant spokespersons have difficulty imagining the possible discomfort of the receivers about their low score. However, the highly avoidant spokespersons who chose a reticent communication style would have felt more worried if they had been in the place of the receiver. We can assume that the highly avoidant spokespersons who chose a reticent rather than a frank communication style were able to empathize with the receivers and imagine the potentially unpleasant impact of the displeasing truth. Nevertheless, worry being the emotion attributed by those spokespersons to receivers, one can wonder if this emotion could be linked to the implicit meaning of personal failure attributed by these spokespersons to the low score of receivers. Therefore, this empathic attitude could be seen as a benevolent facet of the more general negative model of the other that characterizes this attachment style.

Perceptions and Emotions of Anxious Spokespersons

In line with the negative model of self (Bartholomew and Horowitz, 1991) that characterizes anxious attachment, the spokespersons with high anxious attachment would have felt sadder and more in distress, compared to those with low anxious attachment, if they had been in the place of the receiver. The working model of anxious attachment includes preoccupation with intimacy, jealousy, and fear of abandonment, as well as a dependency on close others' approval rather than an internal sense of self-worth (Brennan et al., 1998; Cole, 2001). Since the individuals with anxious attachment have low self-esteem and feel unworthy of love, we might assume that spokespersons with this attachment style would have felt sadder and more in distress if they had obtained a low score because it would have further undermined their image and self-esteem. At the same time, we hypothesize that the characteristics of individuals with anxious attachment might enable them to imagine the possible discomfort of the other.

Regarding the spokesperson's emotions, those with high anxious attachment felt more embarrassed about their high score. This result seems to support the interpretative hypothesis that

the individuals with anxious attachment can understand that the difference between the two scores might have an unpleasant impact on the receiver. Since their working model includes preoccupation with jealousy, perhaps this embarrassment could be linked to the fear of negative reactions of the other, due not only to empathic concerns but also to a fear of the social comparison implicit in the truthful communication of both scores that the spokespersons are asked to convey to their less successful partners.

Perceptions and Emotions of Secure Spokespersons

The spokespersons with high secure attachment would have felt less distress compared to those with low secure attachment if they had been in the place of the receiver. Given that individuals with secure attachment have high self-esteem and are not afraid of being rejected by others (Mikulincer and Shaver, 2016), we may think that spokespersons with such an attachment style would have felt less in distress if they had obtained a low score because it would not have undermined their high image and self-esteem. Another result consistent with the influence of an internal working model of secure attachment during the communication of a displeasing truth is that the spokespersons with a high propensity for secure attachment perceived the receiver as less worried during this unpleasant communication compared to those with low secure attachment. Individuals with secure attachment feel worthy of love and are not afraid to lose the relationship with the other, and thus, the highly secure spokespersons probably perceived the receiver as less worried because they were not afraid that the difference between the two scores would have negative effects on their relationship with the receiver, as it happened in the case of spokespersons with anxious attachment.

Together with these effects on perceptions and emotions of the spokespersons, Study 2 allowed us to grasp how the internal working model linked to their attachment style also influenced perceptions and emotions of receivers of a displeasing truth.

Perceptions and Emotions of Anxious Receivers

First, the receivers with high anxious attachment felt less satisfied and more embarrassed about their low score compared to those with low anxious attachment. This result seems to confirm the low self-esteem in individuals with anxious attachment (Mikulincer and Shaver, 2016). The lack of self-confidence might explain the receivers' dissatisfaction and embarrassment about their low scores.

Another interesting result is that the receivers with high anxious attachment felt more embarrassed, less satisfied, more guilty, and more disappointed about the high score of the spokesperson compared to those with low anxious attachment. Consistent with the working model of anxious attachment, we hypothesize that this is so because their scores were lower than the average and, therefore, they might fear penalizing their partner in a game with the other couples.

Another result that seems to confirm the internal working model of anxious attachment is that the receivers with high anxious attachment perceived the spokesperson as more uncomfortable, less happy, more embarrassed, more in distress, and less safe compared to those with low anxious attachment. We hypothesize that the receivers with high anxious attachment have imagined being a spokesperson, and because the individuals with anxious attachment are afraid of being abandoned and need the other's approval, they might fear the potential consequences of unpleasant communication on their relationship with others and on their image. Further, they felt those emotions because they would have felt them had they been in the place of the spokesperson. This interpretative hypothesis can also explain the result that the receivers with high anxious attachment would feel more in distress if they had been in the place of the spokesperson compared to the receivers with low anxious attachment.

Perceptions and Emotions of Secure Receivers

The receivers with high secure attachment felt more satisfied about their low score compared to those with low secure attachment. In fact, in contrast to the individuals with anxious attachment, those with secure attachment have high self-esteem, and a low score in a computer game is not sufficient to question the self-esteem of these receivers.

Moreover, in line with the working model of secure attachment, the receivers with high secure attachment would feel quieter, prouder, and happier if they had been in the place of the spokesperson compared to those with low secure attachment. We hypothesize that the receivers with a high secure attachment would feel proud and happy about their high score, if they had been in the place of the spokesperson, because in that case, they would be reaching positive goals, like in a vicarious experience of success (Poggi and D'Errico, 2011). In addition, they would have quietly communicated the unpleasant news to their partner without fear of provoking the jealousy of the other and losing the relationship.

Of course, explaining all these results related to perceptions and emotions of both spokespersons and receivers requires more than referring to their internal working models of attachment styles. It is necessary to consider the ability of an individual to imagine the possible reactions of the other and his/her tendency to attribute his/her own emotions to the other. However, it is interesting to note how expectancies foreseen by attachment theory may contribute to explaining and interpreting these results. Moreover, these data also show that the procedure set in place during the study was able to catch specific nuances of these theoretical expectancies, elicited by the specific personal and social challenge of telling a displeasing truth to another person, a stranger to the spokesperson. Not being based on prior interpersonal knowledge, in fact, the perceptions and emotions of both spokespersons and receivers are mostly built up in reference to their own internal working models, and therefore shed a particular light on reactions to this very specific social situation, which goes even beyond the general expectancies included in the original theoretical model.

GENERAL DISCUSSION

Our first study confirmed the relationship between attachment style and the communication of a displeasing truth. The results

of Study 1 show that individuals with a propensity for anxious attachment have more difficulty communicating the displeasing truth; hence, they tend to choose a mitigated communication style to reduce their relational anxiety and modulate the potentially unpleasant impact of the news. In the second study, we applied a more articulated criterion to analyze the verbal content of the spokespersons' communication: overcoming the previous dichotomous classification – straight vs. mitigated communication style – we found that the spokespersons of our procedure may adopt three different ways (reticence, mitigation, and frankness) of communicating the displeasing truth, and specifically distinguished two types of reticent, five types of mitigated, and four types of frank communication. This more fine-grained analysis allowed us to explore how the spokesperson's attachment style induced a preference for one of the three. Further, in Study 2, more research issues were tackled: two new questionnaires administered to both spokespersons and receivers explored each participant's emotions about one's own score, the partner's score, the imagined emotions if he/she were in the place of the partner, and his/her perception of the partner. So, the receivers' reactions were investigated too, allowing us to examine how their attachment style may affect their emotions and perception of the spokesperson. Results of this new analyses show that perceptions and emotions of both spokespersons and receivers of a displeasing truth are influenced by the internal working model linked to their own attachment style. The specific personal and social challenge due to the need of speaking and receiving a difficult truth during an interpersonal communication with a stranger, set in place by the original procedure tested in Study 1 and developed in greater depth in Study 2, makes it evident how perceptions and emotional relations elicited during this communication may be influenced by the internal working models of all partners of this communication, even beyond the expectancies formulated by the theoretical model describing the consequences generally expected by the attachment theory.

CONCLUSION

This paper has explored the underinvestigated issue of how communication of a displeasing truth can be influenced by the attachment style of both senders and receivers of this difficult communication. The complexity of the adopted procedure, along with the time-consuming analysis of the verbal data, necessarily restricted the participants' sample of the two studies presented, but the results of this first exploration are encouraging. In the first explorative study, we observed that the communicative strategies used by the spokesperson to convey to the receiver his/her poor score in a game was influenced by the spokesperson's attachment style, as assessed by the ASQ by Feeney et al. (1994). The results generated by our procedure showed that anxious participants more frequently chose a mitigated communication strategy when conveying a displeasing truth. Nevertheless, this study had some limitations. First, due to the low number of participants, the ASQ scores could not be fully elaborated. Second, the observation was focused only on the spokesperson. Thus, a second study was planned in which, by observing a higher number of participants, we could differentiate a high vs. low similarity of each participant to scores that distinguished each attachment style, as assessed by the ASQ. Moreover, a more in-depth qualitative analysis of the verbal utterances of spokespersons was performed, leading to differentiation of the strategies used by the spokesperson into reticence, mitigation, and frankness, this last definition comprising either a clear communication or even a more brutal communication of the displeasing truth. Finally, Study 2 also investigated the perceptions and emotions of both spokespersons and receivers in this difficult interpersonal communication, in order to explore their links, if any, to their own specific attachment style (secure, anxious, or avoidant).

The results of this second study show that spokespersons with a high propensity for avoidant attachment chose franker communication when conveying to the receivers their poor scores compared to spokespersons with a low propensity for avoidant attachment. In accordance with more general assumptions of avoidant attachment (Bartholomew and Horowitz, 1991; Brennan et al., 1998; Cole, 2001), these data suggest that avoidant spokespersons may use a brutally frank communication truth as a "de-activating" strategy (Cassidy and Kobak, 1988), in order to maximize their relational distance from receivers.

Also, results on perceptions and emotions of both spokespersons and receivers show interesting nuances of the influence of the attachment styles on this challenging interpersonal communication. Taken together, these results suggest that the internal working models linked to specific attachment styles influenced the emotions and social impressions of both members of the couple of participants who, strangers to one another, were asked to be involved in a difficult interpersonal communication. The specific procedure set in place in fact elicited a social comparison between the two, whereby one who was put in a better social position had to communicate bad news about the other's poor performance. The results of Study 2 suggest that each participant's internal working models were used to cope with the difficult communication, whether in the role of spokesperson or receiver. A further suggestion emerging from our data is that dimensional measures of attachment propensity can help to develop more complex explanations, in psychological terms, of a given behavior, rather than simply find a correspondence between a prototypical profile and its associated behavior.

More generally speaking, to understand how people cope with the personal and social challenge of communicating or receiving a displeasing truth, one should reference the internal working models of participants as well as their capacity to foresee the uneasiness felt by the other person (Axia, 1999) and the pragmatic consequences of the inconvenient truth on the social and personal face of the receiver (Goffman, 1967; Brown and Levinson, 1978); and within the literature on politeness, specifically the studies that show how pragmatic consequences can be appreciated if communication is clear and nice. While the first dimension is well explained by the theory of Grice (1975), which indicates that clear communication maximizes

the informative contents, a speaker can be defined as nice when he/she masters the social processes between communicative actors (Lakoff, 1973; Leech, 1983). In other words, if a speaker is clear by avoiding any misunderstanding, he/she is also nice when he/she is aware of the other person's need to protect his/her face. Our studies highlight that participants with a high propensity toward avoidant attachment choose to be extremely frank when communicating a displeasing truth to receivers, with the aim of being clear while neglecting being nice. Participants with a high propensity toward anxious attachment, on the contrary, while fulfilling the aim to be nice, are at the same time less frank, mitigating the clear communication of the displeasing truth. Also, the perceptions and emotions of receivers seem to look for a difficult balance between understanding inconvenient information and protecting the interpersonal relation with the spokesperson. While internal working models linked to secure attachment seem to enable both spokespersons and receivers not to worry about the effects of communicating the inconvenient truth, models linked to anxious attachment seem to expose both communication partners to the disruptive consequences of the social comparison implicit in the difference between the high score of the spokesperson and the low score of the receiver.

Together with the promising results on an understudied issue, the studies presented in this article also have some limitations. First of all, the sample of both studies is not balanced for gender, and due to the priority of our need to test the novelty of the original procedure used in the two studies, we did not explore differences linked to gender roles. More research should be done in order to explore whether gender differences arise in similar studies. Another limitation of the two studies is the fact that only verbal contents were analyzed. Future studies might explore the communication of a displeasing truth in more depth. For instance, the emotions of both spokesperson and receiver could be explored by direct observation using tools such as the Facial Action Coding System (Ekman et al., 2002) and not only questionnaires of self-reported emotions. Finally, a better grasp of multiple nuances of the communicative strategy chosen by a spokesperson when communicating an inconvenient truth might be attained by including an analysis of verbal contents in a more comprehensive multimodal analysis (Poggi, 2007), taking into account not only words and facial expressions but also gestures, gaze, postures, and the intertwining of the meanings they all convey in both spokespersons' and receivers' communication.

Besides a theoretical advancement of the understanding of the relationships between personality and communication, this work might be also of use on the application side, since the possibility of detecting communicative strategies from different attachments styles, or the other way around, might help to build more sophisticated systems for user modeling and the planning of personalized systems.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The manuscript was reviewed and ethically approved by the committee of doctorate' psychology and cognitive science of the Sapienza University of Rome. The patients/participants provided their written informed consent to participate in this study. The procedure was conducted in accordance with the ethical requirements of research prescribed by AIP (Associazione Italiana di Psicologia, Italian Psychology Association).

AUTHOR CONTRIBUTIONS

IS: literature review, method, and qualitative analysis. GL: method, literature review, and writing. FD'E: quantitative analysis, discussion of the results, and writing. IP: qualitative analysis, literature review, and writing.

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A Motivational Model Explaining Performance in Video Games

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Esports are a rapidly growing phenomenon and understanding of factors underlying game performance are therefore of great interest. The present study investigated the influence of satisfaction of basic psychological needs (competence, autonomy, and relatedness), type of motivation (amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation), and number of matches played (time on task) on individuals' performance on a matchmaking rating (MMR) in the video game Defence of the Ancients 2 (Dota 2). Collected data from 315 participants was included in the analyses. A web-based questionnaire was used to collect data and structural equation modelling (SEM) was performed to analyze the data. The results show that perceived competence and autonomy were the only significant predictors of MMR performance beyond matches played. Fulfillment of relatedness, as well as motivational factors, were not found to be predictors of MMR scores. The strong effect of matches played, used as proxy of time on task, emphasize the effect of time and practice as a critical aspect of video-game expertise.

Keywords: self-determination theory, basic needs, intrinsic motivation, extrinsic motivation, time on task, video game performance, Dota 2

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INTRODUCTION

Many people all over the world play video games, independent of gender and across a wide variety of ages. For example, it is estimated that 60% of Americans play video games daily (Entertainment Software Association, 2018), and it is a growing sports phenomenon. E-sport is defined as an organized form of video gaming involving many players either locally or online over the internet. According to Sylvester and Rennie (2017), e-sport, a subcategory of video gaming, is a global activity with no signs of slowing down; the total time spent viewing e-sport is expected to be greater than nine billion hours per year by 2021 (HIS Markit, 2017). According to the Global export market report (Newzoo, 2017), it is estimated that of the 345 million who are involved in e-sport, 45% play, 23% view, and 32% both play and view e-sport. Video gaming is growing, not only as a gaming phenomenon but also as a field of study. Video gaming has been studied from a variety of different areas, such as rehabilitation of gait and balance problems (Ravenek et al., 2016), identifying gaming disorder (Kaptsis et al., 2016), neurological aspect of gaming (Palaus et al., 2017), how gaming affects the brain structure (Brilliant et al., 2019), potential associations between gaming and cognition (Röhlcke et al., 2018; Nuyens et al., 2019), and whether education can be gamified (Kim et al., 2018). Today, video gaming and e-sport are challenging more "traditional" sports in terms of the increasing amount of both recreation players and professional players. However, in comparison to traditional sports, relatively little is known about factors that influence performance.

Indeed, in a recent review, Bányai et al. (2019) argued that few studies have investigated the psychological aspects of e-sports and emphasized that more understanding within this area is essential. For instance, knowledge about gamers' motivational patterns can be helpful when trying to foresee negative consequences such as gaming disorders, which according to the World Health Organization (WHO),[1] is classified as a mental health problem. WHO defines gaming disorders as when "people who partake in gaming should be alert to the amount of time they spend on gaming activities, particularly when it is to the exclusion of other daily activities, as well as to any changes in their physical or psychological health and social functioning that could be attributed to their pattern of gaming behavior[2]". There are, however, also possible benefits of video gaming. It has been suggested that video gaming can improve cognitive processes (e.g., improved attention control and processing speed; Nuyens et al., 2019) and postpone cognitive decline (Griffiths et al., 2013).

Previous studies have identified specific characteristics underlying gaming motivations (Vorderer, 2000; Vorderer et al., 2003; Sherry et al., 2006; Yee, 2006a,b; Greenberg et al., 2010; Demetrovics et al., 2011). For example, Vorderer (2000) and Vorderer et al. (2003) argue that interactivity and competition are two of those characteristics, with the former being related to communication and cooperation, whereas the latter is related to the possibility to compare themselves with other players. In another study, it was found that, for college students, challenges, diversions, and competition were the strongest types of motivation (Greenberg et al., 2010).

Röhlcke et al. (2018) investigated the predictive ability of several factors (i.e., number of matches played, working memory capacity, grit, fluid intelligence, age, and education) for performance in the multiplayer video game "Defense of the Ancients 2" (Dota 2). The study showed that the number of matches played (proxy for time on task) was the strongest predictor of performance, but no effect of cognition was obtained, which is in contrast to other findings (e.g., Nuyens et al., 2019).

The effect of the number of matched played (time on task) is in line with the studies showing that learning and performance progress when time spent on the task increases. In a study of 15-year-old students' homework, Wagner et al. (2008) found a positive but weak relationship between the amount of time students work at home and scholastic achievements. An argument was found valid also for the Programme for International Student Assessment data on student homework; hence, the frequency of homework in mathematics was predictive of students' mathematical performance (Trautwein, 2007) [see also Cooper (1989) and Smith (1990) for similar results]. Findings indicate that time on task is a critical factor for improvements and potentially also for video gaming and e-sport performance–the more you play, the better you perform. Similarly, in a review by Baker and Young (2014), the authors confirmed the importance of practice in more traditional sports (e.g., football).

Why and to what extent time on task is critical for performance are a fundamental question that for the fast-growing e-sport is lacking a clear answer. Gaining knowledge about factors that have an impact on time spent playing is not only interesting from a performance perspective, it may, to some extent, also explain why e-sports are a growing phenomenon and why many people choose to spend a lot of time (or not) on playing e-sports. According to Deci and Ryan (2000), in the self-determination theory (SDT), the satisfaction of the basic psychological needs relatedness, competence, and autonomy are assumed to guide the individual toward a more vital, competent, and socially integrated behavior; especially autonomy and competence plays a significant role in facilitating an individual's intrinsic motivation to perform an activity (Uysal and Yildirim, 2016). These basic psychological needs are considered essential to one's sense of well-being and psychological growth. *Competence* refers to the propensity to strive toward mastery and being optimally challenged. When the *autonomy* need is fulfilled, the individual is left with a sense of control and freedom when performing a specific activity. *Relatedness* refers to having a sense of belongingness and a meaningful connection to others (Deci and Ryan, 2000; Ryan and Deci, 2000b; Uysal and Yildirim, 2016). Motivation, according to SDT, is viewed along a continuum ranging from *amotivation*, *extrinsic motivation*, to *intrinsic motivation.* Amotivation is when one is entirely unmotivated because the activity does not generate feelings of competence, does not bring any value, and does not feel worthwhile. Extrinsic motivation refers to the forms of regulation that underlie actions that individuals perform as means to get to the end, whereas intrinsic motivation is characterized by a genuine interest and passion for an activity (**Figure 1**; Ryan and Deci, 2000a,b).

Extrinsic motivation can be split into four subcategories, depending on whether the motivation type is controlled or autonomous (Deci and Ryan, 2008). These include *external regulation*, *introjected regulation*, *identified regulation*, and *integrated regulation*. External regulation, which is the least autonomous form of motivation, can occur when it is primarily external factors that motivate the individual to perform an activity. These external factors could be either in the form of rewards or punishments. *Introjected regulation* describes a type of motivation that arises when an individual does something to avoid guilt or anxiety or to boost their ego by demonstrating their abilities to maintain or increase their self-esteem. Identified regulation refers to behavior that is associated with greater feelings of freedom and volition because their behavior is more congruent with their individual goals and personal identities. They understand their behavior as a reflection of themselves. Integrated regulation, the most autonomous form of extrinsic motivation, occurs when one identifies with the task, values, and needs that the task brings. The reasons for engaging in an activity are further assimilated to the self and are thus autonomous. However, the individual is still extrinsically motivated (rather than intrinsically motivated) as they engage in the activity based on presumed outcomes, rather than for an inherent passion or interest for the activity (Ryan and Deci, 2000a,b).

Furthermore, research suggests that intrinsic motivation has been associated with positive outcomes, such as performance, concentration, persistence, and well-being, as assessed across different activities and situations (Ryan and Deci, 2000a;

[1] www.who.int

[2] https://www.who.int/news-room/q-a-detail/gaming-disorder

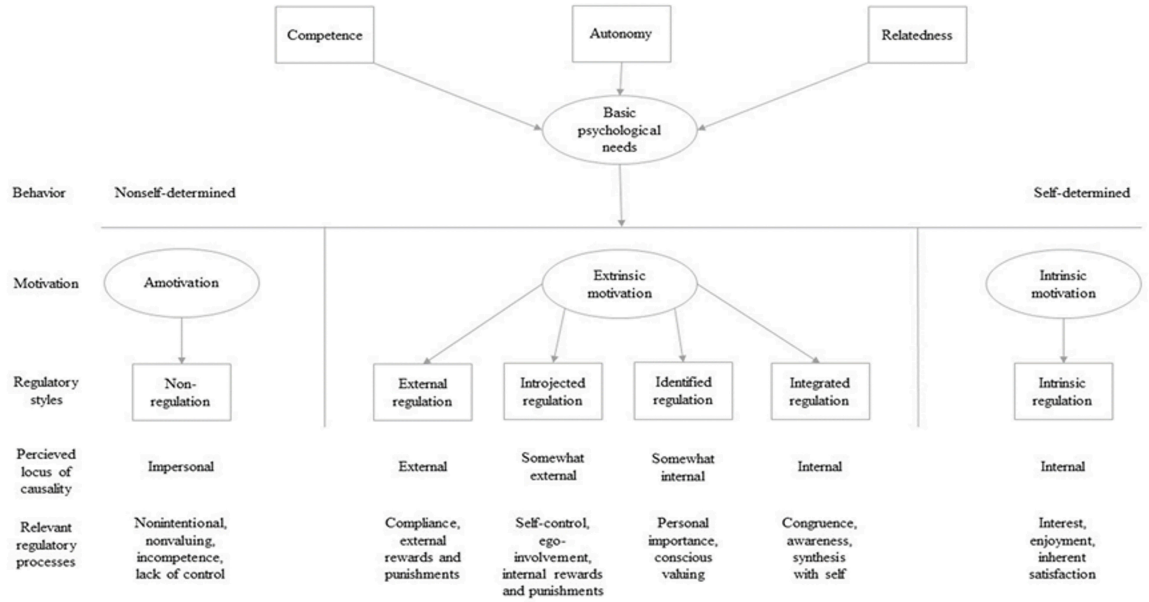

FIGURE 1 | A taxonomy of human motivation, presented on a continuum, ranging from no motivation to controlled and a more autonomous form of motivation. The satisfaction of basic psychological needs forms a more autonomous motivation. The figure add the basic psychology needs to the Ryan and Deci (2000a,b) taxonomy of human motivation.

Gillet et al., 2009). For example, a previous study found a positive correlation between self-determined motivation and performance (i.e., the ratio between the number of victories and the number of matches played), suggesting that self-determined motivation may influence performance among tennis players (Gillet et al., 2009).

With respect to e-sport (as well as for more traditional sports), previous studies have shown that the fulfillment of basic psychological needs is associated with players' willingness to continue playing (e.g., Ryan et al., 2006), which in turn have a large impact on motivation and a positive effect on the development of more intrinsically regulated motivation (Ryan and Deci, 2000a,b). The satisfaction of basic psychological needs may offer an explanation to why people play video games in the first place; the gaming simply enhances the enjoyment and thus provides the satisfaction of their basic psychological needs (Ryan et al., 2006; Przybylski et al., 2009; Tamborini et al., 2010; Rogers, 2017). Potentially, this satisfaction also predicts how likely a player is to continue playing the game in the future (Ryan et al., 2006). However, different types of video games seem to satisfy different basic psychological needs. For example, a recent study by Rogers (2017), who investigated the motivational pull of video games, found that social elements within the games lead to feelings of relatedness, and games consisting of flexible rules encouraged feelings of competence.

As noted above, Röhlcke et al. (2018) pointed out matches played (time on task) as a strong predictor of performance in Dota 2. If matches played are related to performance to the extent suggested by Röhlcke et al. (2018), then it seems necessary to include this factor when investigating the role of time on task on video game performance. In addition, considering the few studies that have investigated the importance of matches played for video game performance (and Dota 2 specifically), there is also a need to replicate the findings by Röhlcke et al. (2018) to be able to establish the findings. The authors did not, however, investigate the effects of different forms of motivation and satisfaction of basic psychological needs on performance in Dota 2. The conjunction of basic psychological needs (autonomy, competence, relatedness), different types of motivation (amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, intrinsic motivation), and matches played (time on task) are therefore critical variables in the present study.

This brief introduction shows that e-sports have established itself all over the world, with certain games having thousands of players (such as Dota 2); it gains more media and public interest. Today, e-sports have become an industry challenging more "traditional" sports. In some e-sports, such as Dota 2, professional players are common. However, compared to more "traditional sports" (team sports and individual sports), relatively little is known about factors that influence game performance, such as time on task. Even less is known to what extent psychological factors such as basic psychological need and motivation play a role. More knowledge about factors that have an impact on time spent playing and competing in e-sports is not only interesting from a performance perspective, but it may also, to some extent, explain why e-sports is a growing phenomenon and why many people choose to spend a lot of time (or not) on playing e-sports.

Aim

The main argument for the present study is to understand to what extent time on task (number of matched played), basic

psychological needs, and motivational factors influence players' online gaming performance. Information that, by extension, can be used to foresee player behavior that potentially can evolve into inadequate social and interpersonal behavior such as gaming withdrawal (Kaptsis et al., 2016). In addition, there is, to our knowledge, no study that has included basic psychology needs, types of motivation, and matches played (time on task) as predictors of video game performance. The aim of the present study was therefore to investigate whether and to what extent the satisfaction of basic psychological needs, different types of motivation, and matches played are associated with the video gaming performance.

MATERIALS AND METHODS

Video Game

In the present study, the real-time strategy (RTS) game Dota 2 was used as the video game of interest. Dota 2 is a free-to-play game and is available on personal computers. The game was developed by Valve Corporation (first released in 2013) and is regarded as a multiplayer online battle and is one of the most successful games with respect to the price money of competitive gaming. Dota 2 had the highest accumulated prize pool distributed among professional e-sport (electronic sports) players in 2019 (E-sports earnings, 2019). The game also has the highest player count for any game on the Valve Corporation platform, and in February 2019, Dota 2 had an average of 475,747 active players playing the game every hour of the day, and there were a total of 11.3 million players registered (Steam, 2019). In Dota 2, two teams of five players compete against each other. The main objective is to destroy the enemy base. Each player controls a hero with unique abilities and characteristics, which are improved throughout the game by leveling up and obtaining different equipment (e.g., armor, arms gloves, etc.) for the hero. Dota 2, currently consists of 117 heroes, 152 items, and more than 480 distinctive spells such as jumping high, flying, becoming invisible, and so on (Röhlcke et al., 2018; Dota 2 Gamepedia, 2019). For the present study, two measures from Dota 2 were used: Matchmaking rating (MMR) and Matches played (see detailed description below).

Procedure

Participants were recruited through advertisements in Dota-specific internet communities (e.g., Reddit) and through email. The email was sent out to participants who had previously participated in a Dota 2 study and had approved to be contacted again. Contact information for new registers was obtained as part of the test battery. The response rate could not be calculated because we could not register how many saw or read the advertisement. In the advertisement, it was emphasized that the study aimed to investigate the relationship between performance, personality, and motivation in Dota 2. If interested to participate, they were asked to fill out the online questionnaire. To be included in the present study, participants needed to have played at least 110 ranked games (see under the description of MMR below) of Dota 2 and a minimum of 10 games during the past month. These selection criteria are similar to what has been used previously (see Röhlcke et al., 2018). The questionnaire used to collect data was distributed using Google forms. Participants were first presented with information about the project, including information related to the fact that participation was voluntary and that participants had the right to cancel their participation at any time. This information was followed by specific instructions and a letter of consent. After providing their informed consent, participants provided their background information, such as age, gender, and highest education level, after which they answered Dota-specific questions and questions about their motivation for playing the game. The survey took approximately 25 min to complete.

Participants

A total of 329 Dota 2 players agreed to participate in the study. An initial screening revealed 14 statistical outliers according to the three-interquartile-range rule, which were consequently removed from the analysis. Thus, the final sample consisted of 315 participants. Among them were 299 males (94.9%) and 13 females (4.1%); 3 participants preferred not to state their gender (1%). The mean age of the participants was 23.32 years (SD = 4.52 years), and participants were recruited from 60 different countries. The level of education attained by the participants in the sample included primary school (4.8%), junior high school (3.0%), high school (23.2%), trade/technical/vocational training (3.5%), some college/university credits (18.4%), professional degree (2.2%), bachelor's degree (35.9%), associate degree (2.9%), master's degree (7.9%), and doctorate degree (1%).

Measures

MMR

A player's MMR score represents performance on Dota 2. In ranked games, an algorithm is used to calculate how many MMRs players win or lose after the game is played. If players win a game, they receive a point between +25 and +30, and if players lose, they receive a point between −25 and −30. More MMRs points are received if the opponents are considered to be overall slightly better, and less if the opponents are considered to be slightly worse. This system places players in games with similarly skilled players. As such, higher MMR scores are indicative of a more highly skilled player, whereas a lower MMR indicates that a player is less skilled (Röhlcke et al., 2018; Dota 2 Gamepedia, 2019). In this study, MMR scores were self-reported by the participants in the questionnaire. Participants are able to retrieve their MMR scores within the game. See Röhlcke et al. (2018) for a full explanation. The mean MMR in this sample was 3359.66 (SD = 1294.17, min = 35, max = 7274). MMR was found to be normally distributed with skewness of 0.0 and kurtosis of −0.2. A threshold of 2 for skewness and 7 for kurtosis have been suggested in the literature (e.g., Finney and DiStefano, 2006).

Matches Played

Participants reported the total number of games played in Dota 2. This information was available for the participants within the game and was thus used as a proxy of "time on task."

The average number of matches played by the participants was 3,552.9 (SD = 2,551.9), with skewness of 1.6 and kurtosis of 2.8, which is acceptable for normally distributed data (Finney and DiStefano, 2006). We do not know the time period taken to reach the number of matches played, but the large spread in data (as indicated by the SD) increases the likelihood of finding plausible effects of matches played on MMR.

Motivation

The Gaming Motivation Scale (GAMS) was used to determine motivational characteristics. The GAMS includes the following factors: (1) amotivation, (2) external regulation, (3) introjected regulation, (4) identified regulation, (5) integrated regulation, and (6) intrinsic motivation. Factors 2 to 5 are each related to extrinsic motivation. Three items represent each of the factors in the questionnaire. Some of them were adjusted slightly to fit the Dota 2 game better. One item was also added to target whether players played the game with the aim of gaining MMR points. For each item, the respondents rated their level of agreement with each using a seven-point Likert scale, with responses ranging from 1 ("do not agree at all") to 7 ("very strongly agree"). Thus, the maximum score for each factor was 21 (three items × seven-point Likert scale). Questions were framed using the following stem: "Why do you play Dota 2?" "Rate your agreement with the following statements." Participants then responded to questions related to intrinsic motivation (e.g., "because it is stimulating to play"), integrated regulation (e.g., "because it is an extension of me"), identified regulation (e.g., "because it is a good way to develop important aspects of myself"), introjected regulation (e.g., "because I feel that I must play regularly"), external regulation (e.g., "for the prestige of being a good player"), and amotivation (e.g., "it is not clear anymore; I sometimes ask myself if it is good for me"). In the present study, skewness ranged from −0.4 to 0.6 and kurtosis from −0.8 to 0.1 for the variables included in GAMS, which demonstrates normally distributed data. For each factor included in GAMS, a mean score was calculated. In a study performed by Lafrenière et al. (2012), GAMS had a Cronbach's α value between 0.75 and 0.89. In this study, the Cronbach's α values were between 0.52 and 0.88. Peterson (1994) suggests that an acceptable Cronbach's α is between 0.50 and 0.60 for preliminary research, whereas for basic and applied research, the Cronbach's α should be at least 0.70. Nunnally (1978) also suggests an acceptable Cronbach's α of 0.70.

Basic Psychological Needs

Player Experience of Need Satisfaction (PENS) was used to measure participant satisfaction related to their basic psychological needs (Ryan et al., 2006). Three items per subscale (competence, autonomy, and relatedness) were used as indicators of each basic need. This scale uses a seven-point Likert scale with responses ranging from 1 ("do not agree at all") to 7 ("very strongly agree"). The questions were framed with the following stem: "Reflect on your play experiences with Dota 2 and rate your agreement with the following statements." Each question then reflected either competence (e.g., "I feel competent at the game"), autonomy (e.g., "I experienced a lot of freedom in the game"), or relatedness (e.g., "I find the relationships I form in this game important"). Skewness ranged from −0.9 to −0.3 and kurtosis from −0.4 to 0.4, thus demonstrating a normally distributed data. A mean score was calculated for each basic psychological need included in PENS. In a study by Lafrenière et al. (2012), it was concluded that an acceptable range of Cronbach's α values for PENS is between 0.72 and 0.80. Cronbach's α values in the present study were between 0.74 and 0.83, indicating acceptable internal consistency (Nunnally, 1978; Peterson, 1994).

Statistical Analyses

First, the descriptive information of the study sample was summarized. Then, zero-order correlations were conducted between all the variables included in the analyses. For descriptive information and correlation analysis, the mean scores for each basic psychological and motivation factor were used. Next, structural equation modeling (SEM) was used to investigate the effects of basic psychological needs, motivation, and matches played on MMR (the dependent variable). For each basic psychological need and motivation factor, single items were used as indicators of the latent variable representing each factor/construct. In the model, type of motivation (amotivation, external regulation, introjected regulation, identified regulation, integrated regulation, intrinsic motivation) was also assumed to be predicted by basic psychological needs (competence, autonomy, and relatedness). Three fit indices were used to evaluate the model, including the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and χ^2 divided by degrees of freedom. To attain an acceptable fit for CFI, the value must be equal to or greater than 0.95 (Browne and Cudeck, 1989). RMSEA values need to be equal to or less than 0.06 to attain a good model fit and 0.08 for a reasonable fit (Browne and Cudeck, 1989; Hu and Bentler, 1999). For normed χ^2 results, the suggested threshold values range from 2.0 (Tabachnick and Fidell, 2007) to 5.0 (Wheaton et al., 1977) in the literature. The data were analyzed using SPSS (IBM Corporation, Armonk, NY, United States) and AMOS 26 (Arbuckle, 2016). Initial analyses revealed that the demographic data were non-significant in relation to the MMR and were therefore excluded from further analysis.

RESULTS

Descriptive data of variables included in the analyses are presented in **Table 1**. As can be seen, for both skewness (range = −0.9 to 1.6) and kurtosis (range = −1.2 to 2.8), the variables included indicated normally distributed data.

Zero-order correlations between the variables are presented in **Table 2**. As can be seen, MMR score was positively associated with matches played, integrated regulation, competence, autonomy, and relatedness. Matches played, highly correlated with MMR, were also associated with amotivation, integrated regulation, and competence. In addition, all factors related to motivation and basic psychological needs were, to a large extent, related to each other. Next, to further investigate the complexity between factors, SEM analyses were performed.

The results of standardized and unstandardized β weights from the SEM analysis accompanied by standard errors and *p* values can be seen in **Table 3**. In the SEM analysis, latent

TABLE 1 | Descriptive data of variables included in the analyses.

Variable	Mean	*SD*	Skewness[a]	Kurtosis[b]
MMR	3359.7	1294.2	0.0	−0.2
Matches Played	3552.9	2551.9	1.6	2.8
Amotivation	3.7	1.9	0.1	−1.2
Intrinsic motivation	5.4	1.0	−0.3	−0.3
Extrinsic motivation				
Identified regulation	4.1	1.4	−0.2	−0.5
External regulation	4.3	1.2	−0.4	0.1
Integrated regulation	3.9	1.5	−0.1	−0.8
Introjected regulation	3.0	1.5	0.6	−0.6
Basic Psychological Needs				
Competence	5.2	1.0	−0.3	−0.4
Autonomy	6.0	0.9	−0.9	0.4
Relatedness	4.2	1.4	−0.3	−0.4

[a]*Std. Error 0.137,* [b]*Std. Error 0.274.*

variables were used to represent each basic psychological need and motivation factor. The factor loadings for the latent constructs ranged from 0.36 to 0.88 (mean = 0.70, SD = 0.15), and 43% of the factors loadings were greater than 0.80. The model indicated acceptable fit with regard to RMSEA (0.065, PCLOSE < 0.001) and normed χ^2 (χ^2/df = 2.320, $p < 0.001$), although poor with regard to CFI (0.880). As can be seen, matches played are a strong predictor of performance (MMR). Among the other predictors included in the model, the basic psychological needs autonomy and competence also reached statistical significance (**Table 3** and **Figure 2**). The remaining basic psychological need, relatedness, and all motivation factors are non-significant predictors of performance. Matches played, which is a strong predictor of MMR score, was similarly as for MMR score positively predicted by basic psychological need factors autonomy and competence. Among factors related to motivation, integrated regulation and amotivation positively related to matches played, whereas intrinsic motivation and introjected regulation are negatively associated with the number of matches played. These factors were, in turn, significantly predicted by many of the basic psychological need factors (**Table 3**), which demonstrates the complexity of the results. The model explained 27% (R^2 = 0.27) of the variance of matches played, and 48% (R^2 = 0.48) of the variance of MMR.

In addition to analyses of direct effects, we also investigated possible indirect (mediating) effects. Results showed that there were a significant indirect effects of matches played on the relationship between competence and MMR (β = 0.175, p = 0.030), but not for relatedness (β = −0.127, p = 0.194) or autonomy (β = −0.032, p = 0.760). Thus, for competence, the number of matches played to some extent can explain the relationship with MMR. For autonomy, however, non-significant effects suggest that the relationship between autonomy and MMR is direct and is not mediated by the number of matches played. There was also a significant indirect effect found of matches played on the relationship between intrinsic motivation and MMR (β = −0.170, p = 0.049). Thus, the result shows that the relationship between intrinsic motivation and MMR is not only direct but also mediated by matches played (time on task). However, matches played did not mediate any effects of introjected regulation (β = −0.118 p = 0.104), amotivation (β = 0.071, p = 0.082), integrated regulation (β = 0.227, p = 0.078), external regulation (β = 0.073, p = 0.133), or identified regulation (β = −0.098, p = 0.349) on MMR.

Because relatedness, identified regulation, and external regulation were not significant as predictors of either matches played or MMR, they were removed for a final trimmed structural model. For this model, all model fits were acceptable (CFI = 0.960, RMSEA = 0.047, PCLOSE = 0.682, χ^2/df = 1.691, $p < 0.001$). As expected, all significant paths toward matches played and MMR remained significant in the trimmed model (**Table 4** and **Figure 3**). The only difference from the main analysis is that autonomy became a significant predictor of integrated regulation. However, this effect was very small.

DISCUSSION

The aim of the present study was to examine whether and to what extent number of matches played (time on task), basic psychological needs, and motivational factors predict

TABLE 2 | Correlations between variables used in structural equation model.

	1	2	3	4	5	6	7	8	9	10	11
(1) MMR	–										
(2) Matches Played	0.59**	–									
(3) Amotivation	0.10	0.14*	–								
(4) Intrinsic motivation	0.02	−0.06	−0.13*	–							
(5) Identified regulation	0.05	0.00	−0.01	0.39**	–						
(6) External regulation	0.07	0.08	0.17**	0.24**	0.30**	–					
(7) Integrated regulation	0.18**	0.12*	0.01	0.39**	0.64**	0.35**	–				
(8) Introjected regulation	−0.02	−0.01	0.27**	0.16**	0.43**	0.48**	0.53**	–			
(9) Competence	0.44**	0.30**	−0.04	0.22**	0.20**	0.23**	0.31**	0.10	–		
(10) Autonomy	0.18**	0.11	−0.22**	0.37**	0.28**	0.12*	0.21**	0.05	0.21**	–	
(11) Relatedness	0.12*	−0.01	−0.03	0.33**	0.39**	0.09	0.30**	0.11	0.16**	0.28**	–

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 3 | Standardized regression weights of the predictor variables used in the structural equation model with matchmaking rating as the dependent variable.

	β	*B*	*S.E.*	*P*
Matches played → MMR	0.41	0.21	0.03	**<0.001**
Amotivation → MMR	0.08	59.49	46.78	0.203
Intrinsic motivation → MMR	−0.19	−397.04	302.69	0.189
Identified regulation → MMR	−0.21	−215.04	184.31	0.243
External regulation → MMR	0.13	153.28	101.80	0.132
Integrated regulation → MMR	0.27	229.72	142.78	0.108
Introjected regulation → MMR	−0.16	−158.65	98.88	0.109
Autonomy → MMR	0.15	286.00	139.97	**0.041**
Relatedness → MMR	0.12	105.25	66.87	0.116
Competence → MMR	0.27	345.27	77.04	**<0.001**
Amotivation → Matches played	0.17	251.93	118.29	**0.033**
Intrinsic motivation → Matches played	−0.42	−1728.09	761.14	**0.023**
Identified regulation → Matches played	−0.24	−493.46	455.55	0.279
External regulation → Matches played	0.18	410.36	251.57	0.103
Integrated regulation → Matches played	0.55	917.60	339.95	**0.007**
Introjected regulation → Matches played	−0.29	−579.78	241.54	**0.016**
Autonomy → Matches played	0.25	935.15	337.21	**0.006**
Relatedness → Matches played	−0.01	−11.88	167.82	0.944
Competence → Matches played	0.25	630.83	191.49	**<0.001**
Competence → Amotivation	0.02	0.03	0.11	0.762
Relatedness → Amotivation	0.09	0.11	0.08	0.180
Autonomy → Amotivation	−0.30	−0.73	0.19	**<0.001**
Competence → Intrinsic motivation	0.18	0.11	0.05	**0.016**
Autonomy → Intrinsic motivation	0.37	0.34	0.08	**<0.001**
Relatedness → Intrinsic motivation	0.25	0.11	0.03	**0.001**
Competence → Identified regulation	0.14	0.17	0.09	**0.049**
Autonomy → Identified regulation	0.14	0.26	0.14	0.061
Relatedness → Identified regulation	0.48	0.41	0.07	**<0.001**
Competence → External regulation	0.26	0.29	0.08	**<0.001**
Autonomy → External regulation	0.18	0.31	0.13	**0.019**
Relatedness → External regulation	−0.06	−0.04	0.06	0.444
Competence → Integrated regulation	0.29	0.45	0.10	**<0.001**
Autonomy → Integrated regulation	0.05	0.11	0.15	0.476
Relatedness → Integrated regulation	0.34	0.35	0.07	**<0.001**
Competence → Introjected regulation	0.08	0.10	0.09	0.277
Autonomy → Introjected regulation	−0.09	−0.16	0.14	0.246
Relatedness → Introjected regulation	0.20	0.17	0.06	**0.008**

β = *Standardized regression weight, B = Unstandardized regression weight, S.E. = Standardized error of B, MMR = Matchmaking rating.*

performance (MMR) in Dota 2. The results showed that basic psychological need competence and autonomy, but not relatedness, were significant predictors of MMR. This finding corresponds, in part, with the findings of Van Nuland et al. (2012), who found that competence was directly associated with persistence and performance. However, no effects were found for motivational factors (direct or indirect) on MMR. In line with the findings of Röhlcke et al. (2018), matches played were a strong predictor of MMR, and it was thus justified to include this factor in the model. A final trimmed structural equation model, in which non-significant predictors from the main analysis were removed, confirmed the overall findings from the main model.

The need competence, which is related to the strive toward mastery and challenges, was a significant predictor of performance. This is in line with the results from Rogers et al. (2017), who recently suggested that games with flexible rules boost feelings of competence, and has previously been linked to performance within traditional sports such as football (see, e.g., Fransen et al., 2018). In this study, we found a similar pattern, which suggests that feeling of competence is a factor that can contribute to player performance. Thus, also within the context of video gaming, it seems reasonable to suggest that competence-promoting strategies are something to strive for to promote performance.

We also found autonomy to be a factor related to performance. Thus, the importance of a sense of control and freedom plays a role for performance in Dota 2. However, the effect was rather small. This was perhaps somewhat surprising considering the general need for autonomy for optimal functioning found in earlier studies (see, e.g., Deci and Ryan, 2004). However, results are in line with previous findings that have reported a more robust relationship between competence and performance than between autonomy and performance (e.g., Cerasoli et al., 2016). The small effect could potentially be explained by the fact that Dota 2 is a team-based game. Even though more training (more matches played) improves performance, the individual player is always dependent on his/her team during a game and therefore, potentially, does not experience a sense of increased autonomy when performance improves as a function of more matches played.

As noted, relatedness was not a significant predictor of MMR. A previous study found that socialization factors were a significantly greater motivator for women who played video games than for men (Sun, 2017). In part, this could explain the non-significant relation between relatedness and MMR in the present study; hence, only 5% of the participants were women. If the population would have been more heterogenic, perhaps relatedness would have been significantly related to MMR.

The non-significant effects for intrinsic motivation on MMR were somewhat surprising and inconsistent with previous research, which have reported intrinsic motivation to be a predictor of performances (Deci and Ryan, 2000; Ryan and Deci, 2000a; Gillet et al., 2009). A possible explanation for this could be that Dota 2 is an externally reward-based game with incentives that have a direct link to performance (i.e., MMR scores are always visible and are a direct reflection of performance). Previous studies have suggested that incentives that have a more direct link to performance do not facilitate intrinsic motivation (Cerasoli et al., 2016). Through the in-game feedback (performance direct incentives), intrinsic motivation could become less vital and extrinsically more vital (Mekler et al., 2017). This argumentation is in line with more recent results, which indicate that more direct incentives do not impact on intrinsic motivation but do have a positive impact on performance (Greene, 2018).

There are, of course, several other possible explanations to the non-significant effects of intrinsic motivation. Players may have explicit motives to play video games, such as to enhance their skill development or to experience various social aspects of the

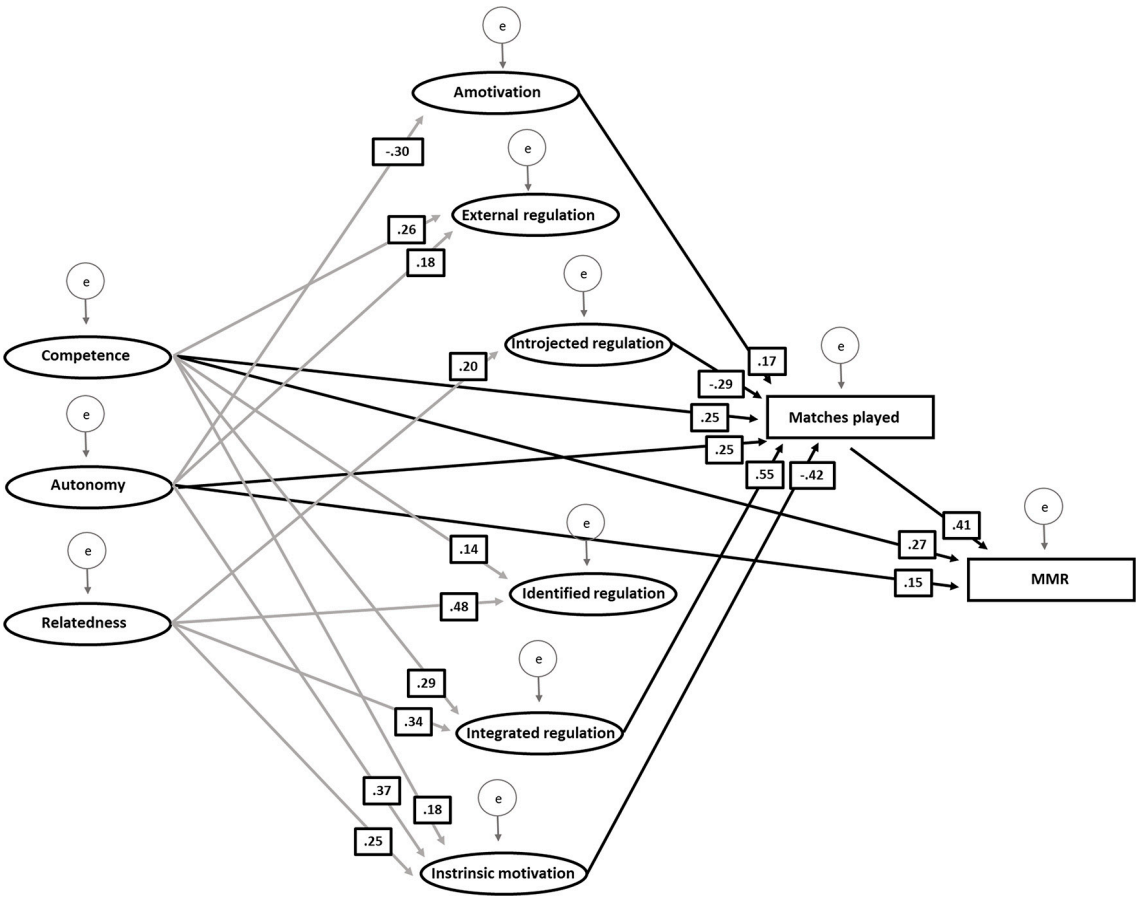

FIGURE 2 | Structural equation model illustrating significant paths together with standardized regression weights between basic psychological needs (competence, autonomy, and relatedness), motivation types (intrinsic motivation, identified regulation, external regulation, integrated regulation, introjected regulation, amotivation), matches played, and matchmaking rating (MMR) in Dota 2. Black arrows show significant relationships on MMR and matches played. Gray arrows show significant relationships between basic psychological needs and the type of motivation. Latent variables are represented by ovals, and all manifest variables are represented by rectangles.

game (Demetrovics et al., 2011; Hamari et al., 2015; Wu et al., 2016). It is also possible that these findings reflect subconscious selection effects. Some players may select games that fit their personality traits (Graham and Gosling, 2013) and satisfy their needs in various ways, whereas some games emphasize social elements, which can lead to feelings of relatedness (Johnson and Gardner, 2010; Rogers, 2017). Another potential explanation for the non-significant relationship between performance and intrinsic motivation is the interaction between personality trait and type of motivation. Previous studies have shown that, although intrinsic motivation is considered an aspect that spurs creativity, it does not work in isolation, but only in combination with certain personality traits (i.e., openness; Prabhu et al., 2008; Agnoli et al., 2015, 2018). This could be an explanation for the non-significant relationship between intrinsic motivation and performance, but because we did not control for personality type in this study, this is only speculation. This highlights the need for future studies to also consider personality when investigating the role of motivational type for performance in a video game context.

Similar to the finding that intrinsic motivation was not related to MMR, it did not have a positive impact on matches played. In fact, there was a negative association between intrinsic motivation and matches played. Possible explanations for this finding are most likely similar to those discussed previously in relation to MMR, related to in-game characteristics. Hence, as the players level up in the game, they are rewarded, suggesting that extrinsic motivation becomes more vital (Mekler et al., 2017).

It should, however, be noted that integrated regulation, a factor underlying extrinsic motivation, which occurs when one identifies with the task and the requirements of the game, was a strong predictor of matches played. Although integrated regulation shares qualities with intrinsic motivation, it is driven by extrinsic goals, such as the in-game incentives, which in turn suggests why integrated regulation was found to be a significant predictor. Introjected regulation, on the other hand, which also is regarded as part of extrinsic motivation, was negatively associated with matches played (time on task). Introjected regulation is related to an individual's motivation to do things not solely because he wants to, but to avoid guilt and for a

TABLE 4 | Standardized regression weights of the predictor variables used in the trimmed structural equation model with matchmaking rating as the dependent variable.

	β	*B*	*S.E.*	*P*
Matches played → MMR	0.44	0.22	0.03	**<0.001**
Amotivation → MMR	0.11	82.08	42.81	0.055
Intrinsic motivation → MMR	−0.12	−254.94	257.98	0.323
Integrated regulation → MMR	0.14	113.47	99.86	0.256
Introjected regulation → MMR	−0.13	−135.16	84.97	0.112
Autonomy → MMR	0.15	281.57	133.72	**0.035**
Competence → MMR	0.29	375.36	72.51	**<0.001**
Amotivation → Matches played	0.19	294.13	107.12	**0.006**
Intrinsic motivation → Matches played	−0.41	−1659.36	668.46	**0.013**
Integrated regulation → Matches played	0.42	662.90	250.98	**0.008**
Introjected regulation → Matches played	−0.27	−548.21	210.37	**0.009**
Autonomy → Matches played	0.24	889.25	332.33	**0.007**
Competence → Matches played	0.28	713.92	175.71	**<0.001**
Competence → Amotivation	0.03	0.05	0.11	0.627
Autonomy → Amotivation	−0.27	−0.66	0.17	**<0.001**
Competence → Intrinsic motivation	0.20	0.13	0.05	**0.009**
Autonomy → Intrinsic motivation	0.47	0.43	0.08	**<0.001**
Competence → Integrated regulation	0.36	0.53	0.11	**<0.001**
Autonomy → Integrated regulation	0.15	0.36	0.16	**0.022**
Competence → Introjected regulation	0.10	0.13	0.09	0.149
Autonomy → Introjected regulation	−0.03	−0.05	0.13	0.680

β = *Standardized regression weight, B = Unstandardized regression weight, S.E. = Standardized error of B, MMR = Matchmaking rating.*

sense of obligation and to protect the individual's ego. Because Dota 2 is a team-based game, which perhaps would support a positive association, this was somewhat surprising. Although speculative, as teammates relatively often change and are easily replaced in Dota 2, and as the player is not forced as an individual player to play with a certain team, it is plausible that the influence of teammates on introjected regulation is less than it would be if teammates where more static and more difficult to replace as in more traditional sports (e.g., football). Still, Dota 2 is a team game where the individual's mistakes become visible and its consequences on the team's performance apparent, it could be perceived as threatening to the individual's ego. If the threat of being revealed as the "weak link" becomes too great, it could perhaps explain why introjected regulation has a negative relationship with matches played. Based on the assumption that the protection of the individual's ego is a relatively central reason for the negative relationship between introjected regulation and matches played (in the present context), this could partly explain the different direction of the relation between introjected regulation and matches played (negative) and integrated regulation and matches played (positive). Because integrated regulation does not place as much focus on protecting the ego, the risk of being exposed as the "weak link" may not be perceived as threatening and thus does not affect motivation to play to the same extent. However, it should be mentioned that previous studies have concluded that more intrinsic and extrinsic motivational tendencies do not rule out one another, but tend to rather dynamically coexist in effecting creativity (Agnoli et al., 2018). This could also be the case when it comes to performance within a video game context. The differences between integrated regulation and introjected regulation in relation to matches played (time on task) illustrate the importance of investigating them separately and not as part of the same construct (extrinsic motivation) in the context of e-sports.

A further surprising finding is the positive relationship between amotivation and matches played. It may seem odd that one plays even more when at the same time unmotivated because the game does not bring feelings of competence, any value, or worthwhile. This result was a major surprise, and there is no straightforward explanation for this finding. One account for this result could potentially be that playing Dota 2, as well as playing other video games, can develop into a regular habit or routine to, for instance, kill time during downtime. Thus, playing Dota 2 can also be driven by factors not related to competence, value, or worthwhile. Instead, playing can be a way to have something to do during periods. However, this is highly speculative, and we do not know if these findings are related to sample characteristics or are specific for Dota 2 players, or video gamers as a whole. Future studies should examine this further.

In this study, we also investigated if matches played could act as a mediator of the relationship between motivational factors and MMR. However, the only significant indirect effect of matches played was found for the relationship between intrinsic motivation and MMR, which was negative. Thus, no motivational factors, not even through other pathways, had any positive effect on MMR. With regard to basic psychological needs, the mediating effect of matches played on the relationship between competence and MMR indicates that competence, in contrast to autonomy, also develops alongside with the number of matches played. It seems fairly reasonable to assume that playing more matches increases the sense of competence, given that the team also wins a fair amount of games.

Although not the primary focus of this study, the results indicated that all three basic psychological needs, competence, autonomy, and relatedness, were significantly predictive of intrinsic motivation. The results from the present study also indicated a negative relationship between autonomy and amotivation. This supports previous research suggesting that all three basic psychological needs are important factors for intrinsic motivation (Uysal and Yildirim, 2016). We cannot determine whether this finding is sample-specific or specific to Dota 2, and therefore, further investigations are needed. It should, however, be noted that previous studies have indicated similar findings (Mitchell et al., 2020).

The present study has some fundamental prerequisites. The sample size was consistent with the European Federation of Psychologists' Associations (EFPA, 2013) guidelines, and the study included participants from 60 different countries. However, a few limitations should be acknowledged. First, the GAMS used in this study had acceptable internal consistencies, except for intrinsic motivation. Our slight adjustments on a few of the items influenced the internal consistency. The reason for these adjustments was to adapt the scale for the specific Dota 2 video game context. However, removing those items did not

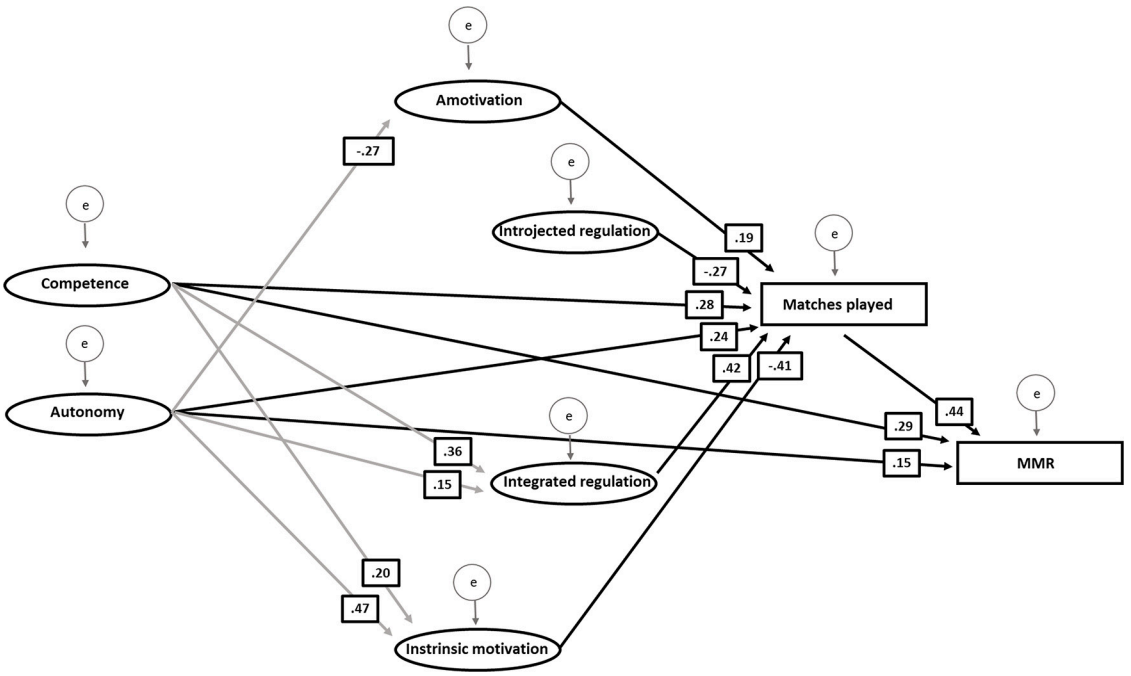

FIGURE 3 | A trimmed structural equation model illustrating significant paths together with standardized regression weights between basic psychological needs (competence, autonomy), motivation types (intrinsic motivation, integrated regulation, introjected regulation, amotivation), matches played, and matchmaking rating (MMR) in Dota 2. Black arrows show significant relationships on MMR and matches played. Gray arrows show significant relationships between basic psychological needs and type of motivation. Latent variables are represented by ovals, and all manifest variables are represented by rectangles.

substantially change the Cronbach's α. Nevertheless, the GAMS scale could be further developed to accommodate different genres in video gaming. Another limitation inherent in a web-based survey as well as for any study using a self-assessment instrument is the lack of control (over, e.g., socially desirable answers), which in turn can affect the validity of the study. However, using the current recruitment strategies (i.e., web-based survey), it enabled us to attract more participants, which in turn could increase the generalizability and reliability of the results. Finally, Dota 2 is an RTS game, and the results obtained in the present study are potentially game-specific and thus may or may not be generalizable to other games or genres.

In conclusion, the present study confirms previous findings that suggest that matches played (time on task) is the strongest predictor of MMR (i.e., performance) in Dota 2. It also confirmed that perceived competence and autonomy could be factors that contribute to player performance. However, the basic psychological need relatedness, as well as motivational factors, does not predict the MMR score. The strong effect of matches played (time on task) is in line with the findings of a previous study (Röhlcke et al., 2018) and further emphasizes the effect of practice time as a critical aspect of video-game expertise.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors have made substantial contributions to the work, revised, and made critical revisions of the manuscript. RH, MN, and BJ developed the research questions. RH, CB, and SR collected the data. RH wrote the first draft of the manuscript. RH, MN, BJ, and DS performed the formal analyses and interpretation of the data.

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Who Watches Live Streaming in China? Examining Viewers' Behaviors, Personality Traits, and Motivations

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With millions of viewers globally, live streaming is a new social media that can deliver video content in real time and with many social interaction functions. Our research aims to understand the personality traits and the motivations of active live streaming viewers as well as their user behaviors in the general population in China. Our results indicate that extraversion was negatively associated with live streaming use, while openness was positively associated. The main motivations to watch live streaming were social interaction, information gathering, and entertainment, and they were associated with different frequencies of use and genre selection. Financial tipping behavior was positively associated with social interaction. Furthermore, motivations mediated the effects of personality traits on live streaming use. People high in openness were more likely to be motivated to chat by information needs. Among extraverts, those who were more social watched fewer streams. We demonstrated that personality traits and motivations can jointly predict live streaming use. The current study not only provides the first evidence of live streaming use with personality traits and motivations but also expands the perspective on individual difference with the mediation analysis. Practically, the person–situation joint interpretation can give industry a clear indication on how to design personalized user experience for people with different personality traits and motivations.

Keywords: live streaming, personality traits, motivations, social media, online tipping

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INTRODUCTION

Live streaming—a new way to deliver video content in real time—has attracted millions of users globally in recent years. The popularity of digital cameras and the increased availability of network access have facilitated the substantial growth of video transmission on the Internet. In 2016, live streaming ranked as the top application of mobile data traffic and accounted for over 34% of total mobile data (Informa Telecoms and Media, 2016). Since 2015, popular services such as YouTube, Facebook, and Twitter have all launched live streaming functions. Twitch, a popular live streaming platform owned by Amazon, boasts over 188 million monthly viewers and 5.5 million monthly broadcasters (Twitch tracker, 2020). In China alone, in 2020, there were more than 559 million live streaming users across about 270 platforms, implying 62% penetration of China's Internet users (CNNIC, 2020). Who are the users of live streaming in China? Why do they adopt this new media

application? The current research seeks to answer the questions by examining the relationship between psychological individual differences of viewers and their behavior engagement.

From a user's perspective, we could draw more inferences about how personality traits and motivations can influence live streaming use. Furthermore, our study of live streaming use in China can contribute to the current body of social medial research from a cultural perspective, providing insights of how culture may influence the way people use live streaming. In addition, our study can offer practical implications for platforms to attract users based on individual needs and personality traits.

LIVE STREAMING

Social live streaming services (SLSSs) belong to the broad category of social network sites (SNSs), while featuring specific characteristics: synchrony, real-time broadcasting of user-generated content, interactions between the viewers and the streamers, and a gratification system (Scheibe et al., 2016). Through live streaming, ordinary people can create content relevant to their own interests and reach niche viewers who share those interests (Lu et al., 2019a). Users are not only consumers and data providers but also content producers as well as volunteers or aspiring professionals in the emerging labor market (Van Dijck, 2009). This creates a diversity of streamers and contents of live streaming, such as game, sport, news, and performance and celebrity shows and a "closer" relationship between streamers and viewers. The interaction between the streamers and the viewers is two-way. During a broadcast, streamers are in the focal point. They can directly acknowledge and respond verbally to viewers, while viewers often type in comments. Viewers can influence the broadcasts by sending virtual gifts to support streamers. Meanwhile, viewers can communicate with each other *via* comments or emojis. Therefore, often there is an interesting cross-model discourse during online streaming (Recktenwald, 2017). As such, the interactions—between the viewers and between the streamers and the viewer—provide a much lively social interaction experience.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

A few studies have examined live streaming in the United States, mainly focusing on the Twitch platform (Sjöblom and Hamari, 2017). For example, Woodcock and Johnson (2019) examined the character action of Twitch streamers, including being friendly to viewers, soliciting donations, building parasocial intimacy with spectators, and engaging audiences through humor. Hilvert-Bruce et al. (2018) explained Twitch live streaming viewer engagement from four aspects: emotional connectedness, time spent, time subscribed, and donations. Despite the fact that China has the largest and fastest-growing group of live streaming users (CNNIC, 2020), very few studies have examined Chinese users. Among a few notable exceptions, some researchers have examined live streaming from the perspective of streamers using a case study of female streamers (Zhang and Hjorth, 2017). Zou (2018) discussed informational capitalism by looking into the structure and affordances of live streaming platforms. In terms of live streaming behaviors, Zhou (2017) explored the associations among users' demographics, usage, and perceptions of live streaming. Lu et al. (2018) investigated how content influences viewing behavior and engagement in Chinese live streaming.

However, research from individual perspectives concerning the factors leading to the use of live streaming in China has been limited. A growing body of evidence suggests that personality traits and motivations are influential in guiding online behavior [for personality traits, e.g., Ross et al. (2009); for motivations, e.g., Jung et al. (2007)]. Therefore, the present study aims to examine individual differences in live streaming use in China.

In the current study, we focus on the viewers, who are the majority of live streaming users. We define live streaming use as viewing streams and communicating through chatting, which are the major basic functions on the platforms. We are also interested in the virtual gifting behavior. As a voluntary payment behavior, it is less commonly used for only around 40% of viewers indicated that they have spent money on paid virtual gifts (iResearch, 2017). Thus, we structure our research questions as follows:

> Research question 1: What personality traits of the viewers are associated with live streaming use?
> Research question 2: What are the motivations in live streaming use and how do these motivations influence user behavior? In particular, what motivations are associated with virtual gifting behavior?

Personality Traits and Live Streaming Use

Personality traits as relatively stable descriptors of individuals' behavior have been used to characterize individual differences since 1950 [for a review, see Schultz and Schultz (2005)]. The "Big Five" personality traits—extraversion, neuroticism, openness to experience, agreeableness, and conscientiousness (Costa and McCrae, 1988)—have been widely used to understand how personality contributes to an individual's behavior.

Briefly, extraversion focuses on sociability, reflecting the tendency to be with others and seek social simulation. Extraverts are typically adventurous, sociable, and talkative. Neuroticism focuses on the experience of negative emotions, such as depression, pessimism, and feeling vulnerable. Openness to experience refers to being creative and open to change. People high in openness normally have broad interests and seek out new and novel experiences. Conscientiousness refers to planning, organization, and perseverance. Conscientious people are dutiful and responsible in their tasks. Agreeableness is about trust, honesty, compliance, and friendliness.

Cheng et al. (2019) found that agreeableness was negatively and neuroticism was positively related to the addictive use of live video streaming, but other personality traits showed no significant relationship. Other scholars looked into the personality patterns of streamers and suggested that low in openness, conscientiousness, and extraversion but high in

neuroticism during the streaming tend to own more popularity (Zhao et al., 2019). However, to our knowledge, no study has yet examined how personality traits are associated with the viewers' general live streaming use. Thus, we grounded our hypotheses in broad SNS research and considered the features of live streaming.

Previous studies indicate that extraverts are sociable and talkative people actively engaging in various activities in the virtual world. For example, extraverts were found to belong to more Facebook groups (Ross et al., 2009) and were more likely to use the communicative functions of SNS (Wang et al., 2012). However, the negative association of extraversion and SNS use was supported by findings from Wang et al. (2012) in using the online gaming functions of SNS. Mark and Ganzach (2014) explained that the popularity of SNS may contribute to the conflicting results. When the popularity grows, more people switch to those online social networking platforms. Therefore, earlier studies tended to find a negative relationship, whereas later findings tended to observe a positive relationship [see Amiel and Sargent (2004) and Mark and Ganzach (2014)]. The level of popularity may also explain the preference of functions of SNSs in the study of Wang et al. (2012). In addition, unlike streamers who are on the stage, viewers in live streaming are often confined in texts, which may also discourage extravert people. Given that live streaming has gained popularity in recent years (Long and Tefertiller, 2020) as well as the viewer's role in live streaming platform, we propose:

H1: Extraversion is negatively associated with viewers' live streaming use.

The neuroticism–loneliness hypothesis proposed that neurotics could use the Internet to avoid loneliness and escape from everyday life (e.g., Hamburger and Ben-Artzi, 2003). Findings have supported that neurotics demonstrate a strong interest in using Facebook for socializing (Ryan and Xenos, 2011; Hughes et al., 2012). The room setting in live streaming forms groups of people with similar interests and facilitates group communication with real-time chat functions. Thus, we suggest this association stands in live streaming:

H2: Neuroticism is positively associated with viewers' live streaming use.

Individuals high in openness are curious and looking for change and novelty (McCrea and Costa, 1999). This relates to seeking novel experiences in SNS with various functions (e.g., Correa et al., 2010; Wang et al., 2012; Mark and Ganzach, 2014). Nevertheless, contrary findings have suggested that openness is not associated with SNS use (Wilson et al., 2010; Hughes et al., 2012) and is even negatively associated with posting selfies on SNSs (Choi et al., 2017), which could be related to the characteristics of different SNS applications. We believe that the tendency to seek novel experiences could be associated with trying new applications of live streaming as well as the rich and diverse content on the platform, and we hypothesize that:

H3: Openness is positively associated with viewers' live streaming use.

From the literature, agreeableness and conscientiousness are comparably less clearly related to social media use (e.g., Ross et al., 2009; Hughes et al., 2012). For example, agreeableness is not related to online contact (Ross et al., 2009), online communication (Mark and Ganzach, 2014), or number of friends on SNSs (Wang et al., 2012). Agreeableness is about trust, warmth, and honesty, which does not suggest particular engagement with live streaming use. Conscientiousness is characterized by achievement-driven and planned behavior, which is often associated with educational achievement (Barrick and Mount, 1991). Live streaming provides a wide variety of leisure content as well as educational programs, which may make the relationship between live streaming use and conscientiousness difficult to identify. Therefore, we suggest:

H4: Agreeableness is not associated with viewers' live streaming use.

H5: Conscientiousness is not associated with viewers' live streaming use.

Motivations and Live Streaming Use

Gros et al. (2017) identified three motivations for using Twitch, including entertainment, information seeking, and socialization. A recent study also suggested that the three most important motivations of using Facebook live are entertainment, sharing opinions and experience, and socialization (Skjuve and Brandtzaeg, 2020). The content of live streaming such as games, performance, and celebrity shows can provide great entertaining experience. Chen and Lin (2018) surveyed Taiwanese people who watch live streaming *via* social network sites and demonstrated that entertainment can drive the usage. Regarding information seeking, a study examined user's information behavior by analyzing the chat logs on Twitch and suggested that topics evolved constantly into important sources of information (Diwanji et al., 2020). In live streaming, viewers can watch not only news but also educational streams about various topics. Lu et al. (2019a) examined the knowledge-sharing streams in China and found that many viewers were motivated to learn from Intangible Cultural Heritage masters through live streams. As social interaction is emphasized in SLSSs use, many studies have documented social interaction as a major motivation for live streaming use (Hu et al., 2017; Wohn et al., 2018). For example, social interaction motivates people to watch different content genres from game streams (Sjöblom and Hamari, 2017) to outdoor and real-life streams (Lu et al., 2019b). Hilvert-Bruce et al. (2018) found that, on Twitch, viewers who preferred small channels were more motivated by social engagement than those who preferred larger channels. Therefore, we propose the hypotheses that:

H6a: Entertainment is one of the motivations of live streaming users and is positively associated with live streaming use.

H6b: Information seeking is one of the motivations of live streaming users and is positively associated with live streaming use.

H6c: Social interaction is one of the motivations of live streaming users and is positively associated with live streaming use.

In addition, Winter et al. (1998) proposed that motivation can mediate the effects of personality traits to predict behavior. From a social cognitive perspective, personality-trait-related differences could appear as differences in perceived efficacy (Bandura, 1977), which could be then associated with motivations. Extensive evidence supporting that self-efficacy belief can affect motivation has been accumulated. For example, writing self-efficacy belief is significantly associated with writing motivation (e.g., Pajares, 2003). Therefore, people's belief in their personal efficacy to interact with others can determine their levels of social motivation. Hence, extraversion facilitates social motivation, whereas introversion deflects it.

In addition, Palmgreen and Rayburn (1982) proposed an expectancy value model which can be used to explain the relationship between personality traits and motivations in media use. They claimed that gratifications from media are a function of a person's beliefs that the media possess certain attributes mediated by the subjective evaluations of these attributes. In the case of live streaming, for extraverts who value socialization, their gratifications could be associated with how the platforms can fulfill their social needs. According to the neuroticism–loneliness hypothesis, neurotics have a strong need of socialization. Similarly, people high in openness who look for diversified content in live streaming could be associated with information motivation. Therefore, we hypothesize that:

H7a: Social motivation can mediate the effects of extraversion in live streaming use.
H7b: Social motivation can mediate the effects of neuroticism in live streaming use.
H7c: Information motivation can mediate the effects of openness in live streaming use.

Nevertheless, several studies found multiple mediation relationships between personality traits and motivations. For example, Graham and Gosling (2013) found that individuals motivated by social networking to play *World of Warcraft* were high in extraversion, agreeableness, neuroticism, and openness. Johnson and Gardner (2010) found that the more open to experience people are, the more likely they are to be motivated by entertainment to play video games. We cannot exclude the possibility of other mediation patterns. Therefore, we would also explore other potential mediation patterns.

While advertising and subscription are major revenue sources for live streaming platforms in western countries, platforms in China mostly monetize by "tipping" system (Li et al., 2018). On Chinese live streaming platforms, users can spend real money to buy virtual gifts and send to streamers during a broadcast. Streamers can cash out 30–65% of the amount of the virtual gifts, and the platforms take the rest, thus providing an important source of income for the streamers as well as the platforms.

Recently, research investigated what drives people to tip and found that social interaction plays an important role (Deng and Chau, 2019; Lee et al., 2019). Lu et al. (2018) interviewed users and suggested that tipping facilitates users to present and express themselves. Tipping also helps viewers win attention and admiration from other viewers. Guan et al. (2020) proposed a model and argued that tipping can build up swift *guanxi* between streamers and viewers. This is consistent with previous findings of virtual goods in online games. The findings suggested that the sociability of online games is significantly associated with the intention to purchase (Animesh et al., 2011) and how much real money players spend to purchase virtual goods (Lee and Wohn, 2012). Therefore, we hypothesize that:

H8: Social interaction is positively associated with tipping behavior in live streaming.

MATERIALS AND METHODS

Participants

An online survey was conducted with 332 adults (18 years old or older) *via* a Chinese survey platform[1]. The platform has more than two million users nationwide. In our analysis, we included only "active viewers" who reported watching live streaming at least 1 day per week, without specifying the platforms that they use. Thus, the final dataset included 210 participants (50% of the participants were males, and 82.9% were between 26 and 40 years old). These participants were from 24 of the 31 provinces in China, including major metropolitan areas and highly populated provinces such as Shanghai (15.7%), Beijing (11.0%), Guangdong (13.8%), Shandong (8.1%), Jiangsu (6.7%), and other provinces.

Measures

Viewers' Behaviors

As described above, viewers can watch and chat during live streaming. Therefore, we used frequency of watching and frequency of chatting to describe viewers' behaviors. The participants were asked how many days per week they watch live streaming (labeled as days, 1 = less than 1 day, 2 = 1 or 2 days, 3 = 3 or 4 days, 4 = 5 or 6 days, and 5 = 7 days), how many streams they watch per day[2] (labeled as streams, 1 = less than one stream, 2 = one or two streams, 3 = three or four streams, 4 = five or six streams, and 5 = more than six streams), and how many times they send messages while watching a live stream (labeled as chat, 1 = never, 2 = one or two times, 3 = three to five times, 4 = more than five times, and 5 = active chatting). *Days* was used to capture whether watching live streaming was a daily activity, while *streams* measured the involvement based on the counts of the live streams. Viewers who use live streaming more often can be indicated by either frequency of watching (days and streams) or frequency of chatting (chat). Additionally, the participants were asked to indicate the genres of live streams that they usually watched from the options *education* (providing knowledge-based content and training courses on various topics), *news* (news from TV channel official account, editorial news, and spot

[1] www.sojump.com

[2] The participants were asked to indicate the number of streams that they watch per day regardless of the length of each stream. The duration of a stream can be controlled by each streamer, while some streams may last from 1 to 3 h.

news), *sports* (live sports events and sports game commentary), *games* (showing the play of video games), *performance* (singing, dancing, or other performance by amateurs), *celebrity* (hosted by famous singers, actors, or other celebrities), and *life* (such as make-up, social eating, feeding pets, creative process of making things or projects, and miscellaneous topics). The categories were adapted from an industry report[3] (iResearch, 2016). For tipping behavior, we measured the actual behavior by asking the participants whether they had spent money to send virtual gifts to streamers (labeled as *spend*).

Personality Traits

Personality traits were measured by the Ten-Item Personality Inventory in China (TIPI-C) (Li, 2013). This scale was devised as a brief measure of The Big Five dimensions of personality for Chinese participants. The TIPI-C has adequate levels of validity and reliability (for subscales, alpha > 0.60). The participants were asked to rate their agreement with different pairs of traits (seven-point Likert scale, from 1 = not at all like me to 7 = very much like me).

Motivations

We used a 15-item scale to assess why people watch live streaming. Items that described motivations of social interaction, entertainment, and information seeking were adapted from previous studies that examine motivations to use SNSs and play social network games (Kim et al., 2011; Lee and Wohn, 2012). Then, we recruited a small group of live streaming viewers, which are around 20 active users, to provide their ideas on the motivations of live streaming use *via* online chat (see **Appendix 1**). Based on the interview, some items were adjusted to fit in the live streaming context (e.g., "to support talented streamers"). The participants were asked to rate their agreement with different motivations for watching live streaming (seven-point Likert scale, from 1 = *not at all like me to 7 = very much like me*). The study sample was considered adequate (KMO = 0.82). The results of a principal component factor analysis revealed three factors: social (Cronbach's α = 0.87), entertainment (α = 0.68), and information (α = 0.57), which explained 61.1% of the variance.

RESULTS

Descriptive Results

Table 1 presents the descriptive statistics of the study sample. A majority of the sample was married (77.6%), had a bachelor's degree or above (86.6%), and had a monthly income above 5 K RMB (approximately 734 USD, 82.4%). To understand whether our sample was representative of Chinese live streaming viewers in general, we compared the demographics of our participants with an industry report and found that the characteristics of our sample are similar to those in the report (iResearch, 2016).

[3]iResearch is a leading provider of online audience measurement and consumer insights in China. The company has provided research reports on live streaming since 2015. They published the 2016 China's mobile video streaming viewers report based on a survey of 1,265 users.

TABLE 1 | Descriptive statistics of the study sample.

	% (*N* = 210)
Age (in years)	
18–25	7.10
26–30	38.10
31–40	44.80
41–50	6.70
51–60	2.90
>60	0.50
Income (monthly, RMB)	
<3 K	3.80
3 K–5 K	13.80
5 K–10 K	61.00
10 K–20 K	19.00
20 K–50 K	2.40
Education	
Elementary	0.50
Technical secondary	0.50
High school graduate	1.90
Technical college	10.50
College graduate	77.10
Master's degree	8.10
PhD or above	1.40
Male	50.00
Married	77.10

Most of the active viewers (74.3%) watched live streaming more than 3 days per week: 25.7% watched on only 1 or 2 days, 38.1% watched on 3 or 4 days, 23.3% watched on 5 or 6 days, and 12.9% watched every day per week. Regarding streams, 12.9% users did not finish one stream per day, 63.3% watched one or two streams per day, and 23.8% were heavy users who watched three or four streams per day. Most of the users enjoyed chatting during live streaming: 92.8% of users chatted at least once per stream, including 38.1% who chatted three to five times, 8.1% who chatted more than five times, and 7.1% who were active/frequent chatters. Moreover, 64.3% of the participants had spent money to send virtual gifts to streamers during live streaming.

As for the genres of live streams, life (61.0%), celebrity (54.8%), and games (48.6%) were most popular; other interests included sports (39.0%), news (38.6%), performance (38.1%), and education (29.0%). Most people (95.7%) chose more than one genre they liked. The participants were motivated to watch live streaming by entertainment (M = 5.54, SD = 0.71), information (M = 5.18, SD = 1.16), and social (M = 4.27, SD = 1.13). As for personality traits, our participants were high in conscientiousness (M = 5.15, SD = 1.03), agreeableness (M = 4.96, SD = 0.94), openness (M = 4.88, SD = 1.10), and extraversion (M = 4.86, SD = 1.25). However, they were comparably low in neuroticism (M = 3.01, SD = 0.93).

We found that those who watched streams more often also chat more often (see **Appendix 2**, zero-order correlational matrix). There were significant correlations between days and chat (r = 0.43, $p < 0.01$) and between streams and chat (r = 0.23, $p < 0.01$). It seems that married people (r_{chat} = 0.24, $p < 0.01$),

people with higher incomes ($r_{days} = 0.17$, $p < 0.01$; $r_{streams} = 0.21$, $p < 0.01$; $r_{chat} = 0.17$, $p < 0.05$), and those with higher education ($r_{days} = 0.17$, $p < 0.05$; $r_{streams} = 0.16$, $p < 0.05$) were more active viewers (**Table 2**). However, gender was not associated with the frequency of live streaming use nor with motivation.

Chi-square test was used to explore the relation between genres of live streams and demographic variables. There were significant gender differences in the preferred genres. Females watched education ($\chi^2 = 5.20$, $p < 0.05$), celebrity ($\chi^2 = 8.48$, $p < 0.01$), and life ($\chi^2 = 15.69$, $p < 0.01$) more than males did, while males preferred sports ($\chi^2 = 23.13$, $p < 0.01$) and games ($\chi^2 = 12.89$, $p < 0.01$). News and performance were watched more often by married than single participants ($\chi^2_{news} = 14.33$, $p < 0.01$; $\chi^2_{performance} = 4.05$, $p < 0.05$) and elder than younger adults ($\chi^2_{news} = 13.60$, $p < 0.05$; $\chi^2_{performance} = 12.01$, $p < 0.05$).

Personality Traits and Viewers' Live Streaming Use

We conducted hierarchical regressions using days, streams, and chat as dependent variables and personality traits as independent variables (**Table 3**). After the demographic variables were controlled for, personality traits explained an additional 3–6% of the variance of the regression models. Extraversion was associated with less live streaming use ($\beta_{streams} = -0.19$, $p < 0.05$). Openness was a significant predictor of days and chat ($\beta_{days} = 0.23$, $p < 0.05$; $\beta_{chat} = 0.29$, $p < 0.01$). We also used logistic regression to explore the relations between personality traits and genres of streams. People high in openness chose more games (OR = 1.83, $p < 0.01$), while more agreeable people had less interest in news (OR = 0.65, $p < 0.05$).

Thus, we found supporting evidence for H1 that extraversion is negatively associated with viewers' live streaming watching, for H3 that openness is positively associated with live streaming use in terms of both watching and chatting, and for H5 that the effects of conscientiousness were insignificant. H2, which hypothesized that neuroticism would be positively associated with live streaming use, was not supported. For H4, we only found agreeableness to be associated with one genre preference.

Motivations and Viewers' Live Streaming Use

The regression analysis indicated that social ($\beta_{days} = 0.21$, $p < 0.05$) and information ($\beta_{days} = 0.21$, $p < 0.05$; $\beta_{chat} = 0.21$, $p < 0.01$) were significant predictors in live streaming use (**Table 4**). After the demographic variables were controlled for,

TABLE 2 | Correlational analysis of user behaviors and demographic variables.

Variables	1	2	3	4	5	6	7
1. Days							
2. Streams	0.26**						
3. Chat	0.43**	0.23**					
4. Gender[a]	−0.04	−0.07	0.06				
5. Age	−0.03	0.01	−0.01	−0.15*			
6. Income	0.17*	0.21**	0.17*	0.06	0.15*		
7. Education	0.17*	0.16*	0.07	0.03	−0.08	0.29**	
8. Marital status[b]	0.06	0.1	0.24**	0.03	0.44*	0.23**	0.10

*[a] 1, male; 2, female. [b] 1, single; 2, married. N = 210; *p < 0.05, **p < 0.01.*

TABLE 3 | Hierarchical regressions examining viewers' behaviors with personality traits.

	Model 1			Model 2		
	Days	Streams	Chat	Days	Streams	Chat
Gender[a]	−0.07	−0.10	0.02	−0.07	−0.10	0.03
Age	−0.08	−0.06	−0.15	−0.05	−0.04	−0.12
Income	0.14	0.17*	0.13	0.12	0.17*	0.12
Education	0.11	0.11	−0.02	0.11	0.11	−0.03
Marital status[b]	−0.05	−0.08	−0.27**	−0.03	−0.08	−0.24**
Openness				0.23*	0.14	0.29**
Conscientiousness				−0.10	0.04	0.00
Extraversion				−0.03	−0.19*	−0.05
Agreeableness				−0.07	−0.04	−0.10
Neuroticism				0.01	0.04	0.04
Adjusted R^2	0.03	0.04	0.07	0.05	0.05	0.11
$\triangle R^2$				0.04	0.03	0.06*

*The numbers show standardized beta coefficients. [a] 1, male; 2, female. [b] 1, single; 2, married. N = 210; *p < 0.05, **p < 0.01.*

TABLE 4 | Hierarchical regressions examining viewers' behaviors with motivations.

	Model 1			Model 2		
	Days	**Streams**	**Chat**	**Days**	**Streams**	**Chat**
Gender[a]	−0.07	−0.10	0.02	−0.08	−0.08	0.01
Age	−0.08	−0.06	−0.15	−0.08	−0.03	−0.14
Income	0.14	0.17*	0.13	0.13	0.15*	0.11
Education	0.11	0.11	−0.02	0.10	0.10	−0.04
Marital status[b]	0.05	0.08	0.27**	0.00	0.05	0.21**
Social				0.08	0.20*	0.12
Entertainment				0.05	−0.12	0.00
Information				0.19*	−0.02	0.21**
Adjusted R^2	0.03	0.04	0.07	0.08	0.07	0.13
$\triangle R^2$				0.06**	0.04*	0.08**

*The numbers show standardized beta coefficients. [a]1, male; 2, female. [b]1, single; 2, married. N = 210; *p < 0.05, **p < 0.01.*

TABLE 5 | Logistic regressions (LR) predicting genres of streams with motivations.

	Education	**News**	**Sports**	**Games**	**Performance**	**Celebrity**	**Life**
Gender[a]	2.13*	0.82	0.21**	0.31**	0.73	2.41**	3.27**
Age	1.02	1.43	1.19	0.95	0.87	0.77	1.19
Income	1.26	0.63*	1.02	1.31	0.97	1.44	0.85
Education	1.17	1.52	1.53	0.93	1.11	0.81	0.96
Marital status[b]	0.96	3.52*	0.45	0.97	3.10*	0.97	0.70
Social	1.31	1.06	0.89	1.54*	1.56*	1.63**	0.76
Entertainment	0.50**	0.75	0.91	1.60*	1.61*	0.78	1.27
Information	1.31	1.36	1.56**	1.01	0.67*	0.74	1.47*
LR χ^2	23.03**	31.26**	36.88**	32.19**	19.49*	23.60**	24.41**

*The numbers show the odds ratios. [a]1, male; 2, female. [b]1, single; 2, married. N = 210; *p < 0.05, **p < 0.01.*

motivations explained an additional 4–8% of the variance of the regression models. Therefore, these results support H6b and H6c.

The logistic analysis revealed that people motivated by the social factor preferred games (OR = 1.54, $p < 0.05$), performance (OR = 1.56, $p < 0.05$), and celebrity streams (OR = 1.63, $p < 0.01$) (**Table 5**). People who looked for entertainment were likely to watch fewer education streams (OR = 0.50, $p < 0.01$) but more games (OR = 1.61, $p < 0.05$) and performance streams (OR = 1.60, $p < 0.05$). Those who wanted to obtain information watched more sports (OR = 1.56, $p < 0.01$) and life streams (OR = 1.47, $p < 0.05$) but fewer performance streams (OR = 0.67, $p < 0.05$).

TABLE 6 | Hierarchical regressions predicting motivations with personality traits.

	Social	**Entertainment**	**Information**
Openness	0.07	0.00	0.28**
Conscientiousness	−0.13	0.11	0.07
Extraversion	0.29**	0.17	0.05
Agreeableness	−0.15	0.03	−0.12
Neuroticism	−0.09	0.13	−0.11
Adjusted R^2	0.12	0.00	0.16

*All demographic variables were controlled for. The numbers show standardized beta coefficients. N = 210; *p < 0.05, **p < 0.01.*

TABLE 7 | Hierarchical regressions examining viewers' behaviors with personality traits and motivations.

	Days	**Streams**	**Chat**
Social	0.03	0.27**	0.12
Entertainment	0.07	−0.11	−0.00
Information	0.21*	−0.05	0.16
Openness	0.17	0.13	0.23**
Conscientiousness	−0.12	0.09	0.00
Extraversion	−0.06	−0.24**	−0.09
Agreeableness	−0.04	0.00	−0.05
Neuroticism	0.02	0.08	0.07
Adjusted R^2	0.08	0.10	0.15

*All demographic variables were controlled for. The numbers show standardized beta coefficients. N = 210; *p < 0.05, **p < 0.01.*

We also found that personality traits were significantly correlated with motivations. Hierarchical regressions (**Table 6**) showed that extraversion was a positive predictor of social motivation (β = 0.29, $p < 0.01$) and openness significantly predicted information motivation (β = 0.28, $p < 0.01$).

To explore the mediation relationship between personality traits and viewers' live streaming use, we conducted a regression analysis with the motivations controlled for **Table 7**. We found

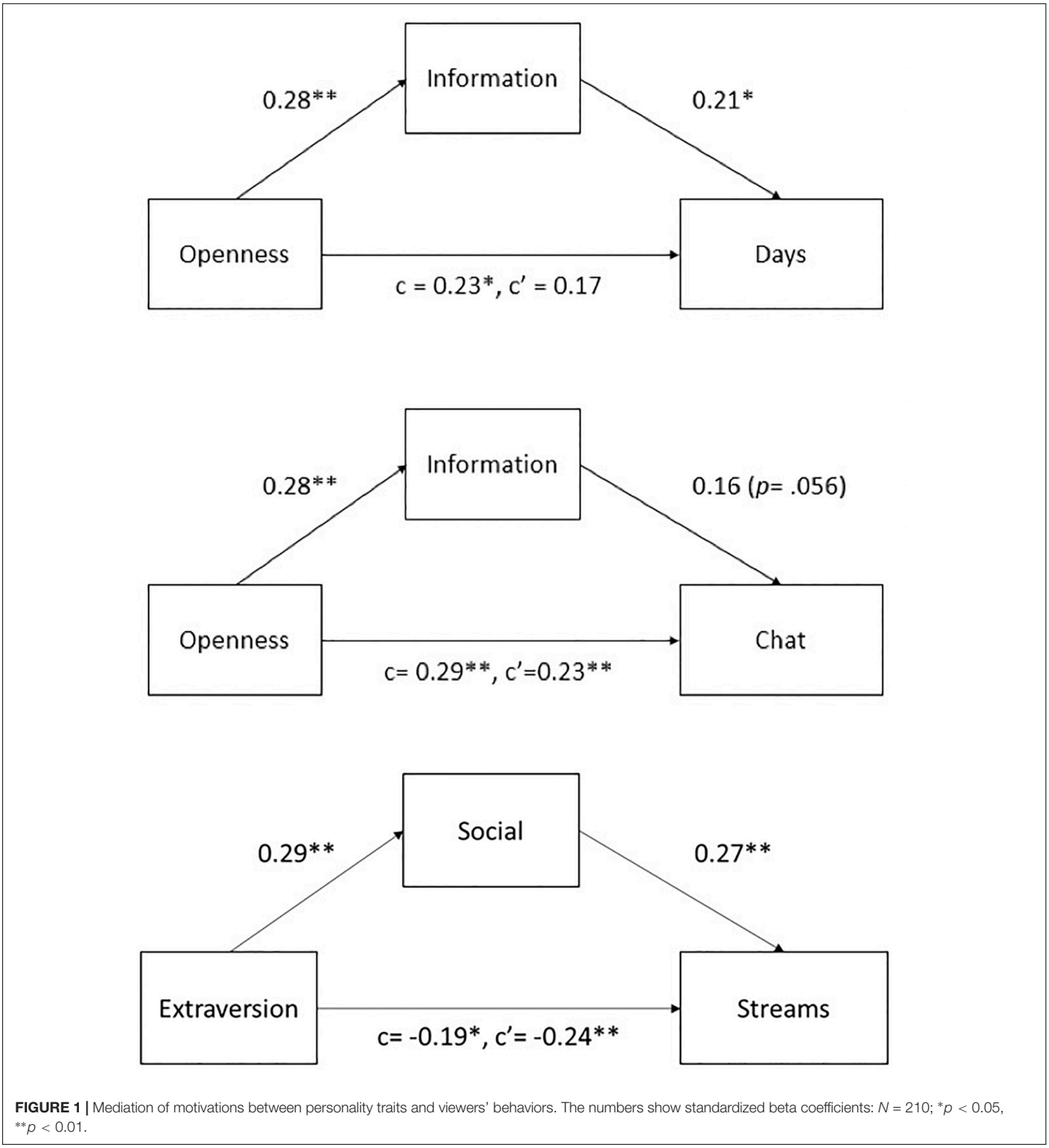

FIGURE 1 | Mediation of motivations between personality traits and viewers' behaviors. The numbers show standardized beta coefficients: $N = 210$; $^{*}p < 0.05$, $^{**}p < 0.01$.

that information mediated the effect of openness (**Figure 1**). After controlling for the effect of information, openness was no longer a significant predictor of days [$\beta = 0.23$, $p < 0.05$; mediated $\beta' = 0.17$, $p = 0.069$; Sobel test $z = 1.97$, $p < 0.05$, variance accounted for (VAF) = 22.6%]. The coefficient of chat became smaller ($\beta = 0.29$, $p < 0.01$; mediated $\beta' = 0.23$, $p < 0.01$; Sobel test $z = 1.72$, $p = 0.08$, VAF = 14.5%); however, the mediation on chat was not significant. Interestingly, we also found an inconsistent mediation from extraversion to streams through social motivation (MacKinnon et al., 2007). After controlling for the effect of extraversion, social was a positive predictor of streams ($\beta = 0.27$, $p < 0.01$). This shows that the use of live streaming by extraverts is motivated by social needs. However, after controlling for the effect of social, extraversion had an even

stronger negative relation with streams ($\beta = -0.19$, $p < 0.05$; mediated $\beta' = -0.24$, $p < 0.01$, Sobel test $z = 2.11$, $p < 0.05$, VAF = −36.6%). Here social motivation acted as a suppressor variable. Among participants who were extraverted, those who were more socially motivated tended to use live streaming less. These evidences support our H7a and H7c that motivations mediate the effects of personality traits in live streaming use.

Finally, logistic regressions were conducted to analyze tipping behavior. First, we analyzed tipping behavior with viewing and chatting behavior. The results showed that people who chatted more (OR = 2.02, $p < 0.01$) were more likely to spend money on tipping. However, whether to tip was not associated with viewers' demographics ($p \geq 0.07$). Then, we examined tipping behavior with motivations. The results showed that people who were motivated by social (OR = 2.25, $p < 0.01$) were more likely to spend money on tipping. These results support H8 that social interaction is positively associated with tipping behavior.

DISCUSSION

The current study tried to answer the question based on an analysis of Chinese viewers: How do individual differences in terms of personality traits and motivations affect live streaming use? In particular, how does the mediation relationship between personality traits and motivations can benefit our understanding? Furthermore, we discuss how culture may influence tipping behavior in live streaming.

How Do Personality Traits and Motivations Affect Live Streaming Use

The findings provide a personality profile of Chinese live streaming users as more open and less extravert. This demonstrates that live streaming is different from SNSs like Facebook that affords self-presentation to gain popularity among others. In such platform, the extrovert users engage more actively by status updating or commenting, while neurotic users are more likely to post contents and gain social support (Shen et al., 2015). The community of live streaming is centered on the interaction of creating and sharing content of diverging interests. Live streaming in China accommodates broad topics, such as education or creative project making; it can fit the diverse interests of open people (Lu et al., 2018, 2019a). This attracts high openness personality profiles of viewers. Among all the personality traits, openness was a strong predictor of live streaming use in terms of both days per week of watching and chat frequency. The content of live streaming also supports the community. In our study, neuroticism was not associated with any live streaming use. Our hypothesis that neuroticism was associated with more live streaming use was built on the proposition that neurotic people use new media to seek support and companionship. This is supported by the positive relationship between neuroticism and use of chat rooms (Hamburger and Ben-Artzi, 2000) and instant messaging (Ehrenberg et al., 2008). However, the viewers of live streaming are rather atomized as their comments are more often around the streamers and broadcasting. Viewers have less chance to build relationships with others and find group identification. It is also reflected in our results that the association between neuroticism and social motivation was not significant. This may explain why our hypothesis was not supported.

In general, personality traits have less influence on genre selection than motivations. Our results showed that entertainment was associated with preference *of games and performance* streams. Moreover, different genres attract viewers with different motivations. For example, performance streams attract viewers who seek social interaction and entertainment but not those who look for information. Education streams were likewise less chosen by viewers motivated by entertainment. It seems that entertainment was more related to genre selection than general usage frequency, whereas information was strongly associated with usage frequency and communication behavior. Among the three motivations, social interaction not only predicted genre selection (games, performance, and celebrity) but also viewing frequency and tipping behavior. According to Gros et al. (2017), socialization was correlated with time and money spent on Twitch, while entertainment and time spent exhibited a low degree of correlation. It seems that social interaction, information, and entertainment could motivate viewers to participate in live streaming, while the strength of their influence and the aspects of user behavior (e.g., watch frequency, chat, and genres) they affect can be varied. Future research can explore this further in consideration of platform differences and other measurements of user behavior.

In addition, we explained how motivations can mediate the effects of personality traits to influence user behaviors in live streaming. Dweck and Leggett (1988) presented a model for motivational and personality processes and demonstrated that both situational variables and dispositional variables play important roles in producing behavior. Many previous studies examined social media use by either personality traits or by motivations. We suggest that person–situation interaction could be a better way to understand user behavior. For example, the inconsistent indirect effect showed that social motivation suppressed extraverts' likelihood of participating in live streaming, which explained the negative association between extraverts and live streaming use. It is possible that extraverts cannot promote themselves freely and carry out their social skills as viewers in live streaming. Our results also indicated that information mediated the relationship between openness and live streaming use. As Chinese live streaming platforms provide viewers with free access of all content, it could facilitate the need of information seeking and well accommodate people high in openness. Therefore, the interpretation of both personality traits and motivations can yield valuable insight into live streaming use.

How Culture May Influence Tipping Behavior in Live Streaming

One feature of live streaming is that users can directly provide financial support to streamers. According to survey, among 31.5% of users who spent money on Twitch, majority paid for subscription (Gros et al., 2017), whereas in China, 40% of users paid for streams all through virtual gifting and, remarkably, 5% of

users spent more than 134 USD (equal to 1,000 RMB) monthly. Culture may influence the tipping behavior in live streaming. Evidence suggests that the cultural orientation of vertical collectivism can predict buying virtual goods with real money in social network gaming (Lee and Wohn, 2012). Triandis (1995) demonstrated two types of collectivism: horizontal collectivism, which emphasizes group membership and equality among group members, and vertical collectivism, which indicate the difference in status and hierarchy among group members. On the one hand, our results indicated that people are more likely to spend when they engage with others. Zhu et al. (2017) analyzed the tipping data from *Douyu* platform and found that viewers often follow others to send virtual gifts. If virtual gifting is the social norm in Chinese live streaming, viewers who want to find group identity need to adopt this practice. In this sense, virtual gifting could be a conformity behavior motivated by the group identity. On the other hand, in many Chinese live streaming platforms, there are a number of gift types with a wide range of values, from a 0.1 RMB "like" to a 500 RMB "rocket". Sending high-value gifts to streamers can create special visual or audio effects, such as flashing lights through the browser window, and can attract attention from streamers and other viewers. The platforms also designed different badges and titles to distinguish viewers who send high-value gifts from other viewers who paid less and provided those high-value gift senders with privileges. These symbolically demonstrated that hierarchies attract people who seek status in live streaming and motivate them to enhance their presence through tipping behavior (Li et al., 2018). On *Douyu* platform, the 2.7% high-value gift senders contributed to 80.2% of the total gift value (Zhu et al., 2017). It seems that both horizontal collectivism and vertical collectivism could contribute to the phenomenon of virtual gifting in China, which is reflected by the different dynamics of social interaction. Future research can investigate this question with more refined measurement on tipping behavior through a cross-cultural analysis.

Limitations, Future Research, and Implications

Our current research provides a personality profile of Chinese live streaming users and corroborates previous evidence on the motivations of live streaming use. Importantly, our findings contribute novel insight into how person–situation jointly could be used in interpreting viewers' livestreaming use. Theoretically, this expands the perspective on individual difference in livestreaming use. Viewers with different personality traits could be motivated by different needs, which together shape their livestreaming use.

Practically, the findings of the current study suggest that strategies targeted to different viewer's personality profile can be applied to attract users. For neurotics who cannot find enough social support in livestreaming, platforms could promote small-sized channels where a close interaction is allowed. Platforms could support economic and inclusion opportunities for streamers with disabilities, mental health issues, or physical health issues. These streamers can build up an inclusive community for people who encounter similar difficulties in life through sharing experiences and encouraging each other, which can be beneficial to both streamers and viewers (Johnson, 2019). For extravert viewers who need more exposure and cannot be satisfied with current infrastructure in live streaming, platforms can design functions to recognize viewers who contribute to the channel by posting, commenting, and participating other than virtual gifting with additional prizes. Viewers can attract followers, which can maintain their enthusiasm and extend their social network. Other functions to facilitate direct interaction between viewers can also enhance the interaction between viewers and develop a sense of group identity.

Although this research offers new insight into the individual difference of livestream viewers, it has some limitations. First, viewers' behavior can be defined in different ways. Besides the variables that we used, duration of streams watching and interaction behaviors can also describe different aspects of live streaming use. Regarding the tipping behavior, although we did not find an association between income level of viewers and whether they chose to spend, the findings could have been restricted by the measure. Determining how much users pay for tipping or how often they tip could provide more details to explain this behavior. Second, our study surveyed users across platforms and explored the general usage patterns of live streaming as a homogenous activity. However, platform and content differences were not included, which could be a noteworthy factor in determining user behaviors (Lu et al., 2019a). Although most viewers select multiple genres, user behaviors and motivation can be varied. In addition, viewers watch live streams not only *via* SSLSs but also by some other applications. For example, *Taobao*, the biggest online shopping platform, used live streaming for product sales. The relationship between viewers' behaviors and personality traits and motivations can change as the context changes. Further research could examine specific platforms, content, and new application to understand the use of live streaming.

CONCLUSION

The current study is one of initial attempts to explore viewers' personality traits and motivations related to live streaming use in the general population in China. Results indicated that extraversion and openness were two major personality traits, and social, information, and entertainment were the three motivations that associated with viewers' live streaming use. Furthermore, we found that motivations can mediate the effects of personality traits, demonstrating that personality traits and motivations jointly influence live streaming use. It provides novel insight into understanding the various degrees of social interaction in live streaming from individual differences. The personality profile of Chinese viewers can also support a future cross-cultural study to understand live streaming user behaviors.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by USC-SJTU Institute of Cultural and Creative Industry Ethnic Board. The participants provide their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

YY was responsible for collecting data and part of the analysis. YX was responsible for part of the analysis and all other work including idea generation, analysis and writing. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: 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 1. MOTIVATIONS IN LIVE STREAMING USE

Participants were recruited through referral (snow-ball sampling). They have used different live streaming platforms such as *Douyu*, *YY*, *Bilibili*, *Momo*, *Huya*, *etc*. They were asked questions about their use experience of live streaming to assure that they are active users. Then, they were asked to provide ideas about motivations of live streaming using elaboration *via* online chat (approximately 10 to 30 min), depending on the details that were provided within the open-ended questions.

The chat transcript was analyzed by a conventional approach (Hsieh and Shannon, 2005). The coded items identified more than two times were selected. These items were compared with items from existing scales. Then, the items were adjusted and rephrased to fit in the live streaming context. For example, "maintain and improve relationship" (Lee and Wohn, 2012) was adjusted to "develop close relationship" and "develop business relationship". The final 15 items in the scale were discussed by a research team who met to gain consensus.

TABLE A1 | Factor analysis of motivations.

Items	Factor 1 social	Factor 2 entertainment	Factor 3 information
1. Find people with same interests	0.71		
2. Develop close relationship	0.74		
3. Maintain current relationship	0.76		
4. Find companion	0.69		
5. To communicate with others	0.78		
6. Develop business relationship	0.69		
7. Support talented streamers	0.69		
8. Follow the trend	0.49		
9. Relieve boredom		0.51	
10. Cheer myself up		0.69	
11. Feel relaxed		0.67	
12. Forget my problems		0.49	
13. To pass the time		0.67	
14. Get new information			−0.58
15. Learn or improve skills			−0.33
Proportion, %	32.15	16.31	10.53
Cumulative, %	32.15	48.46	58.99

APPENDIX 2

TABLE A2 | Zero-Order Correlational Matrix of Personality Traits, Motivations, and Live Streaming Use.

Variables	1	2	3	4	5	6	7	8	9	10
1. Openness										
2. Conscientiousness	0.43**									
3. Extraversion	0.60**	0.41**								
4. Agreeableness	0.32**	0.44**	0.13*							
5. Neuroticism	−0.27**	−0.45**	−0.38**	−0.44**						
6. Social	0.20**	0.01	0.30**	−0.08	−0.10					
7. Entertainment	0.10	0.11	0.16*	0.04	0.01	0.14*				
8. Information	0.36**	0.24**	0.31**	0.08	−0.20**	0.56**	0.04			
9. Days	0.19**	−0.02	0.08	−0.03	0.01	0.20**	0.07	0.25**		
10. Lives	0.07	0.02	−0.07	−0.00	0.04	0.21**	−0.09	0.11	0.26**	
11. Chat	0.27**	0.06	0.14*	−0.00	0.01	0.27**	0.03	0.32**	0.43**	0.23**

*N = 210; *p < 0.05, **p < 0.01.*

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Impact of HEXACO Personality Factors on Consumer Video Game Engagement: A Study on eSports

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This article aims to uncover novel insights into personality factors and consumer video game engagement modeling. This research empirically validates the role of specific HEXACO personality factors that foster consumer engagement (CE) in electronic sports (eSports) users. Using a survey-based approach, we incorporated the HEXACO 60 items and consumer video game engagement scales for data collection. Data were collected from eSports users, with 250 valid responses. WarpPLS 6.0 was used for partial least squares–structural equation modeling analyses comprising measurement and structural model assessment. The results showed that the reflective measurement model is reliable and sound, whereas the second-order formative measurement model also meets the criteria of indicator weights and collinearity values variance inflation factor (VIF). The results based on the structural model indicate that openness to experience, extraversion, agreeableness, and conscientiousness positively predict CE in eSports. This article is first among others that conceptualizes and validates the HEXACO personality traits as a reflective formative model using the hierarchical component model approach. The research model carries the explanatory capacity for CE in eSports concerning personality dimensions as indicated by the HEXACO model. It highlights the potential benefits of such research especially to marketers who could potentially employ personality modeling to develop tailored strategies to increase CE in video games.

Keywords: consumer engagement, eSports, personality factors, HEXACO 60 items, PLS-SEM approach

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INTRODUCTION

Background

Electronic sports (eSports) has become an emergent form of entertainment, with more than 380 million global viewers. Global consumer spending on video games is rapidly growing: from a total of $137.9B in 2018 to a forecasted value of $180.1B by 2021 (Pannekeet, 2018). Within gaming, competitive, tournament-based, and sport-geared video games are categorized as eSports (Jenny et al., 2017); eSports can be played real time on a myriad of platforms ranging from personal computers to gaming consoles (e.g., StarCraft II, online FIFA games (Breidbach et al., 2014; Seo and Jung, 2016). Electronic sports popularity has attracted the attention of marketers and academic scholars because of its avid-fan following (Xiao, 2019). The present research takes the first few steps toward investigating personality factors that drive consumer engagement (CE) in eSport video games.

Extensive assessment of CE in games requires unified and cross-disciplinary efforts toward understanding the relationship between users and analogous game play–related products/services (Fortes Tondello et al., 2018). Video games provide avenues for engagement where users can connect and collectively participate in multifaceted game play (Hollebeek et al., 2017). Collaborative information sharing resulting from player-to-player interaction is one of the reasons for CE (Ul Islam et al., 2017) alongside other factors that are potentially shaped by an individual's unique temperamental attributes (Reyes et al., 2019). Research exploring how personality factors influence CE can have myriad of benefits especially from commercial standpoints; for instance, such research can aid business managers choose better market segmentation and targeting strategies based on personality-based attributes (Ul Islam et al., 2017).

Given the fact that personality is a significant factor in influencing human–computer interaction in games (Sulaiman et al., 2018), it makes sense to ascertain users' personality characteristic in efforts to develop tailored games that drive engagement in consumer game–related interactions. "Big Five" personality attributes have been extensively investigated in previous game-focused projects and others as well (Marbach et al., 2016; Ul Islam et al., 2017; Delhove and Greitemeyer, 2018; Reyes et al., 2019), with more recent research being conducted in online-game settings (Lachlan and Maloney, 2008; Alsawaier, 2018; Sulaiman et al., 2018; Shin, 2019).

The existing research has mostly employed the Big Five personality attributes, and very limited research exists that has investigated the impact of the HEXACO personality factors on CE, especially in online video game settings. Consumer engagement is defined as "A psychological state that triggers due to two-way interactions between the consumer and video game product, i.e., eSports game, which generates a different level of consumer engagement states (cognitive, affective and behavioral)" (Abbasi et al., 2016, p. 249). As per the definition, consumer video game engagement is a higher-order formative construct that comprises three main dimensions (Abbasi et al., 2019b). Our research addresses this gap by specifically employing the fundamentally unique personality model – HEXACO, which comprises factors that include honesty–humility, emotionality, extraversion, agreeableness, conscientiousness, and openness to experience – to study the impact of personality traits on CE in eSports context. Prior studies investigating CE in video games have explored research topics such as video game addiction and scholastic achievements (Skoric et al., 2009); video games for rehabilitation (games to enhance physical therapy) (Lohse et al., 2013); mental health issues associated with video games such as stress, anxiety, and depression (Loton et al., 2016); gender differences in video game play (Jamak et al., 2018); playful-consumption experiences (Abbasi et al., 2019a,b); engagement in violent games and its link to aggressive behavior (Przybylski and Weinstein, 2019); and educational games in STEM subjects (Zuiker and Anderson, 2019). Recently, Reguera et al. (2020) have quantified engagement through playful environment, that is, video game playing.

So far, however, there is little debate on personality traits that have the potential to trigger CE in eSports environment. Hence, we cover this phenomenon in our study. This research is novel as we extend the concept of CE in eSports video games and explore the role of HEXACO personality factors in predicting CE. Besides, our study is first among others who conceptualizes and validates the HEXACO personality traits as a reflective formative model using the hierarchical component model approach.

Rationale for Using the HEXACO Model

The most commonly used personality trait models include the Big Five model and the "five-factor" model. Both these models carry the capacity to predict individual personality traits in terms of five major personality dimensions that include conscientiousness, agreeableness, extraversion, openness to experience, and neuroticism (Costa and McCrae, 1992). In 2000, Ashton et al. (2000) conducted a study to reassess the structure of the English personality lexicon; their research comprised lexical studies of the personality structure based on approximately a dozen languages. The outcome of their research resulted in a personality model that was later categorized as HEXACO model (Ashton et al., 2000; Ashton and Lee, 2007). HEXACO-PI-R considers the six main dimensions of personality comprising of honesty–humility (H), emotionality (E), extraversion (X), agreeableness (A), conscientiousness (C), and openness to experience (O) (Lee and Ashton, 2016). Recently, Abbasi et al. (2020) emphasized that HEXACO-PI-R was better at predicting the personality differences between individuals when compared against existing personality models. HEXACO-PI-R model is akin to the Big Five model with regard to three dimensions: extraversion, conscientiousness, and openness to experience (Ashton and Lee, 2007). However, the HEXACO-PI-R model presents an additional dimension, that is, honesty–humility, and modifies the existing factors such as agreeableness and emotionality of the Big Five model. Therefore, we believe that the HEXACO model is a better substitute for existing personality models including the Big Five and the five-factor models. The benefits of choosing HEXACO over existing models are manifold. For instance, HEXACO models are established on lexical studies of personality-descriptive words in multiple languages (Lee and Ashton, 2004; Ashton et al., 2014). Also, the HEXACO model offers a more comprehensive outlook on individual personality because it has additional factors that were not accounted for in existing personality models (Worth and Book, 2014). In light of its myriad of benefits, we employ the HEXACO personality model to examine the role of personality traits that influence consumers' engagement in eSport games.

HYPOTHESIS DEVELOPMENT

Honesty–Humility

According to Ashton and Lee (2009), honesty–humility is a unique characteristic of the HEXACO personality model. Individuals having this attribute are honest, modest, fair, and generous (Zeigler-Hill and Monica, 2015). They avoid manipulating other people for their gains. Individuals lacking this

attribute are often classified as cruel, selfish, and manipulative (Andrus, 2018). To be more specific, honesty–humility is the propensity to be fair and authentic with others, even at the cost of personal suffering (Hilbig et al., 2013).

In the context of video games, individuals with pronounced personality characteristic would avoid engaging in video games. Previous research supports the notion that honesty–humility is not associated with gaming preferences (Zeigler-Hill and Monica, 2015). Honest and concerned individuals usually avoid playing video games in entirety (Worth and Book, 2014).

We thus hypothesize:

H1: Honesty–humility has a negative association with consumer video game engagement.

Emotionality

An emotional individual is often sensitive, touchy, restless, and fearful (Ashton et al., 2014). Emotionality also explains an individual's depressive tendencies and desires to seek emotional assistance (Andrus, 2018). Individual scoring high on emotionality scale are susceptible to anxiety and pain (McGrath et al., 2018).

Some studies indicate a positive relationship of emotionality with video game engagement (Worth and Book, 2014), however, in general, most studies indicate that emotional individuals avoid participating in online video games because such games can lead to disappointment or critical analysis from other players (Zeigler-Hill and Monica, 2015). According to Zeigler-Hill and Monica (2015), emotionality factor is congruent to neuroticism explained by the Big Five personality factors and is negatively associated with the daredevil preferences that are common in online video games. Personalities with elevated levels of emotionality may be uncomfortable with sensation-seeking features of daredevil preferences. A highly emotional individual often tends to avoid engaging with online video games as it involves the risk of condemnation and disapproval from others. We thus hypothesize:

H2: Emotionality has a negative impact on consumer video game engagement.

Extraversion

An extravert is usually chatty, lively, dynamic, conversational, and enthusiastic (Topete, 2010). Extraverted individuals are more inclined to interact in online settings (Choi et al., 2015). According to Choi et al. (2015), extraverts are socially skillful, eager to uptake activities, and are driven to develop unique interpersonal social linkages. In the context of video games, researchers examined the positive relationship of extraversion with video game play. For example, a study related to personality and video game genres indicated a positive association of extraversion with role-playing games, action role-playing games, and real-time strategy games (Peever et al., 2012). Similarly, research suggests that progressively extraverted individuals seem to relish challenging situations often present in different game genres (Teng, 2008). Thus, we hypothesize:

H3: Extraversion has a positive association with consumer video game engagement.

Agreeableness

Highly agreeable individuals tend to be relatively more trustworthy, helpful, adaptable, accommodating, and forgiving (Choi et al., 2015). Agreeableness alludes to a cohort of positive emotions toward others and often associated with approachability and friendliness (Marbach et al., 2016). On the other hand, we also regarded agreeableness as the opposite of aggressiveness and anger. In game playing, aggressiveness and anger caused annoyance among players. A gamer who is quick and temperamental usually suffers from being criticizing during game play. Players understand that it is difficult to be accepted in the eSport community if they are aggressive. Rather than having an intolerable personality and being outcast, players have chosen to be more helpful to achieve a certain goal together. The feeling of being outcast in the eSport community or in a particular group will cause a feeling of nonbelongingness; therefore, many players have prevented the development, action, or expression of aggressiveness. The suppression effect of aggressiveness leads to a higher utility in game playing.

Highly agreeable individuals care about the contentment of others and therefore would value their commitments on online platforms (Marbach et al., 2016). Furthermore, highly agreeable personalities are more likely to report higher levels of expertise, enjoyment, and control in video games (Johnson et al., 2012). We thus hypothesize:

H4: Agreeableness has a positive association with consumer video game engagement.

Conscientiousness

Conscientiousness is a personality factor focused on achievement, success, discipline, accountability, and cautiousness (Choi et al., 2015). Conscientiousness personalities are cautious, well-organized, and consistent in their dealings (Topete, 2010). Such individuals perform well in professional team-based settings (Lin et al., 2001). Individuals who score high in conscientiousness tend to embrace novel experiences with vigilance (Major et al., 2006). Such individuals can competently accomplish tasks by analyzing perceived information with clarity and focus; research indicates that conscientious personalities would thrive in achievement-oriented environments such as online-game settings (Teng, 2008; Topete, 2010). Therefore, we hypothesize that:

H5: Conscientiousness has a positive association with consumer video game engagement.

Openness to Experience

Individuals who are open to experience tend to be more creative, versatile, open-minded, adventurous, and in pursuit of new ideas and experiences. Such personalities actively engage in shooting games, action-oriented games, role-playing, and other similar genres (Teng, 2008; Johnson and Gardner, 2010). These personalities are receptive to different types of synthetic characters and narratives present in video games

(Johnson et al., 2012). Furthermore, it has been established that a positive association exists between openness to experience and consumer video engagement (Johnson et al., 2012; Marbach et al., 2016; McGrath et al., 2018), thereby demonstrating that individuals with high openness tend to be more receptive of video games and in general more active in video game play. Thus, we hypothesize that:

H6: Openness to experience has a positive association with consumer video game engagement.

Based on the six hypotheses above, **Figure 1** portrays the relationships under study.

MATERIALS AND METHODS

A Cross-Sectional Study

A cross-sectional survey design was implemented that allowed us to gather responses instantaneously, thereby expediting the process of data collection (Mills and Gay, 2019). Another advantage of this survey approach was that it provided us with information regarding the overall behavior of our participant population.

Participants

This study involved teenagers aged between 14 and 19 years. Initially, data were gathered from different gaming zones in Rawalpindi and Islamabad. Furthermore, the study also collected data from teen students because this population has the highest tendency to actively engage in digital game-playing behavior (Adachi and Willoughby, 2016). Once we had a list of gaming zones located in both cities such as Rawalpindi and Islamabad, we then applied the randomizer tool to randomly select twenty gaming zones for data collection. Visiting each gaming zone, we first inquired whether eSports games such as CS Go, Call of Duty, PUBG, and so on, are being played. If the answer is yes, then we formally took the permission from the owner of a gaming zone and sought the consent from all eSports users (who were available at times of our visits), as well to formally start the data collection procedure. A questionnaire survey was administered to gather data from eSports users. To determine the required number of participants, we performed the power analysis using the G*Power 3.1.9.2 (Faul et al., 2007). During the analysis, we gave the following input parameters; test family – *F*-tests; statistical test – linear multiple regression: fixed model; R^2 deviation from zero, type of power analysis – *a priori*: compute required sample size – given $\alpha = 0.05$, power = 0.95, and effect size = 0.15; and number of predictors = 6. Based on the input parameters, the recommended samples size was 146 [minimum required sample to perform partial least squares–structural equation modeling (PLS-SEM) analyses] with actual power = 0.950.

Measures and Procedure for Data Collection

The questionnaire designed for this study has three major parts. The first part of the instrument is related to the demographics of respondents. It provides us with general information such as age, gender, qualification, frequency of video game play, average hours of play, genres of games played, commonly used platforms for game playing, and location where games are most frequently played.

The second part of the instrument is related to HEXACO personality factors adopted from the 60-item English version of the HEXACO-PI-R (Lee and Ashton, 2004, 2016). This part examines the six personality factors of our participant population, including honesty–humility, emotionality, openness to experience, agreeableness, extraversion, and conscientiousness.

The final part of the instrument is related to consumer video game engagement. Responses were collected regarding cognitive, affective, and behavioral engagement of the players with online video games. The scale was adapted from the previous literature, which has been formerly applied to assess consumer video game engagement (Abbasi et al., 2019a). We adapted this scale because it covers more aspects including cognitive, affective, and behavioral factors comparing the existing scales such as game engagement scale (Brockmyer et al., 2009), user engagement scale (Wiebe et al., 2014), and revised game engagement model (Procci et al., 2018). Besides, the dimensions of consumer video game engagement have achieved sufficient reliabilities and other validity tests (Abbasi et al., 2016, 2017, 2019a).

The main variables consist of the higher-order formative constructs from the HEXACO personality model (included the six personality factors). The individual personality factors were derived from associated aspects of participants' personality. For instance, honesty–humility involves modesty, greed avoidance, sincerity, and fairness. Emotionality was captured from fearfulness, anxiety, dependence, and sentimentality. Extraversion was extrapolated from social self-esteem, social confidence, sociability, and liveliness. Agreeableness was deduced from factors such as forgiveness, gentleness, flexibility, and patience. Conscientiousness was determined from aspects such as organization, diligence, perfectionism, and prudence. The final HEXACO personality factor called openness to experience was reasoned from aesthetic appreciation, inquisitiveness, creativity, and unconventionality (Ashton and Lee, 2009).

Similarly, consumer video game engagement stemmed from a mix of cognitive, behavioral, and emotional aspects of an individual's personality. All these three states of engagement were further elaborated: cognitive aspects were further extended into conscious attention and absorption; emotional or affective aspects were garnered from factors such as dedication and enthusiasm; and finally, behavioral engagement was surmised from factors such as social connection and interaction.

All the items in the questionnaire related to the main constructs were assessed on the Likert scales ranging from 1 to 5 (strongly disagree, disagree, neutral, agree, strongly agree).

To test the reliability of the questionnaire, a pilot study was conducted to evaluate the feasibility of the key steps, as well as to check for clarity of questions, grammatical mistakes, the feasibility of sampling technique, determining appropriate sample sizes, and reckoning overall feasibility of scale (Van Teijlingen et al., 2001). To test the reliability, we

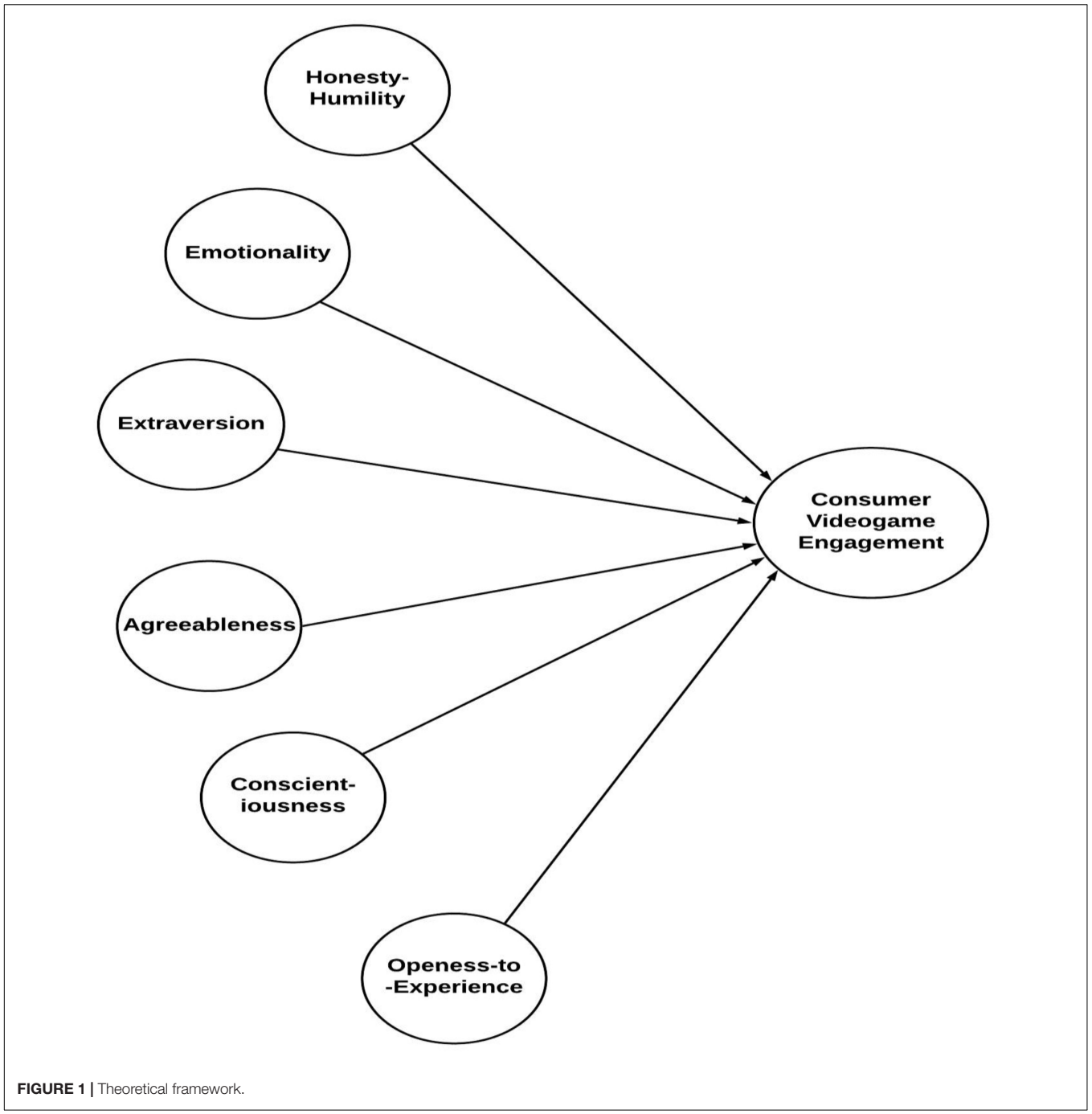

FIGURE 1 | Theoretical framework.

distributed 30 questionnaires to different respondents during the preliminary study.

Upon getting the response from the pilot study, we did some revisions, to ensure the correctness of the questionnaires as well as to ensure that a proper sampling protocol can be achieved. We then distributed 350 questionnaires, and 280 responses were collected. Once the data were collected, missing values and incomplete responses were identified and deleted using casewise deletion (Hair et al., 2016). As a result, 250 valid cases were left for further analysis, which also meets the minimum requirement for PLS-SEM analysis. See **Table 1** for respondents' profile.

Data Analytical Approach

Partial least squares–structural equation modeling is a complete multivariate statistical investigation tool that was employed in this study to verify the study model (Hair et al., 2011). We applied the PLS-SEM approach because it can accommodate the testing of complex modeling (Hair et al., 2016, Hair et al., 2017). In addition, our study model comprised the

TABLE 1 | Shows the demographic profile of the respondents.

Demographic analysis	
Respondents profile	**Percentage %**
Age	
14–15	9.6
15–16	8.4
17–18	30.8
19	51.2
Gender	
Male	78.8
Female	21.2
Qualification	
SSC	11.2
Diploma/Intermediate	34
Fresh Undergraduate	28
Undergraduate	26.8
Frequency of game playing	
Everyday	46
Once a week	18.4
A few times a week	35.6
Average hours of a game played	
1–4 h	85.6
Above 4–8 h	13.6
Above 8–12 h	.8
Most common games played	
PUBG	58
Counter-Strike	93.6
League of Legends	86
Call of duty	84.4
Others	74.4
The most common platform used	
Personal computer	58
Dedicated gaming console	20.8
Smartphone	80.8
Wireless devices	97.2
Other	2.8
Location of game playing	
Home	76.4
Friend's place	12.4
Cyber café	8.8
Others	13.6

higher-order constructs such as personality traits and consumer video game engagement. Because of the complex nature of higher-order constructs (our study involved the reflective and formative measurement models), we believe that the PLS-SEM technique can be employed for the data analyses. Moreover, our study is exploratory and based on theory development. Several studies have acknowledged that PLS-SEM is considered appropriate for exploratory studies and complex modeling involving reflective and formative constructs (Hair et al., 2017; Sarstedt et al., 2019) and theory development (Kline, 2015; Sarstedt et al., 2017). To examine the PLS-SEM analysis, our study is using the WarpPLS version 6.0, developed by Kock (2012).

FINDINGS

The present study followed a two-step process that is based on the measurement and structural model. First, the researcher assessed the measurement model for authenticating reliability and validity of the variables, and second, the structural model was appraised to explain the associations between the main variables.

Step 1: Measurement Model Assessment

The theoretical model (**Figure 1**) shows the two main higher model constructs that are HEXACO personality factors and the consumer video game engagement. **Figure 1** further elaborates the model into the first-order, second-order, and third-order/higher-order constructs. All the personality factors are second-order formative constructs; these are derived from the first-order reflective constructs; for example, the model illustrates that honesty–humility (second-order formative construct) is derived from fairness, greed avoidance, modesty, and sincerity (these are first-order reflective constructs). Personality characteristics are further derived from other attributes, which are stated in **Figure 2** and categorized as first-order reflective or facet-level constructs for this study (Ashton et al., 2014). As explained in **Figure 2**, consumer video game engagement is a third-order formative construct. It is split into three main second-order formative constructs that include cognitive engagement, affective engagement, and behavioral engagement. These factors are elaborated further by first-order reflective constructs; for example, cognitive engagement is measured through conscious attention and absorption (Abbasi et al., 2017, see **Figure 2**).

To evaluate the reliability and validity of the model, the study first analyzes all the first-, second-, and third-order constructs in the stated order, respectively.

Assessment of First-Order Reflective Constructs

To assess the reliability and validity of first-order reflective constructs, the study checked three criteria such as internal consistency using Cronbach α and composite reliability (> 0.70), outer loadings (should be ≥ 0.40), convergent validity (AVE > 0.50), and discriminant validity (Sarstedt et al., 2014). The results on reflective constructs indicate that all constructs have achieved the threshold values as suggested (see **Table 2**).

Table 3 shows the discriminant validity for the reflective constructs. All the diagonal values reported in the table represent the square root of the AVE of each construct. To reach discriminant validity (Fornell and Larcker, 1981), this value should be greater than its parallel correlation coefficients. In the table, all the diagonal values are greater than the off-diagonal values. Thus, discriminant validity is not an issue in this study (see **Table 3**).

Assessment of Second-Order Formative Constructs

To assess second-order formative constructs, a two-stage method was adopted (Becker et al., 2012). To find the validity of the second-order formative construct, variance inflation factor (VIF) of all the items must be assessed, and the value should be less than five as recommended by Hair et al. (2011) or 3.3 as recommended

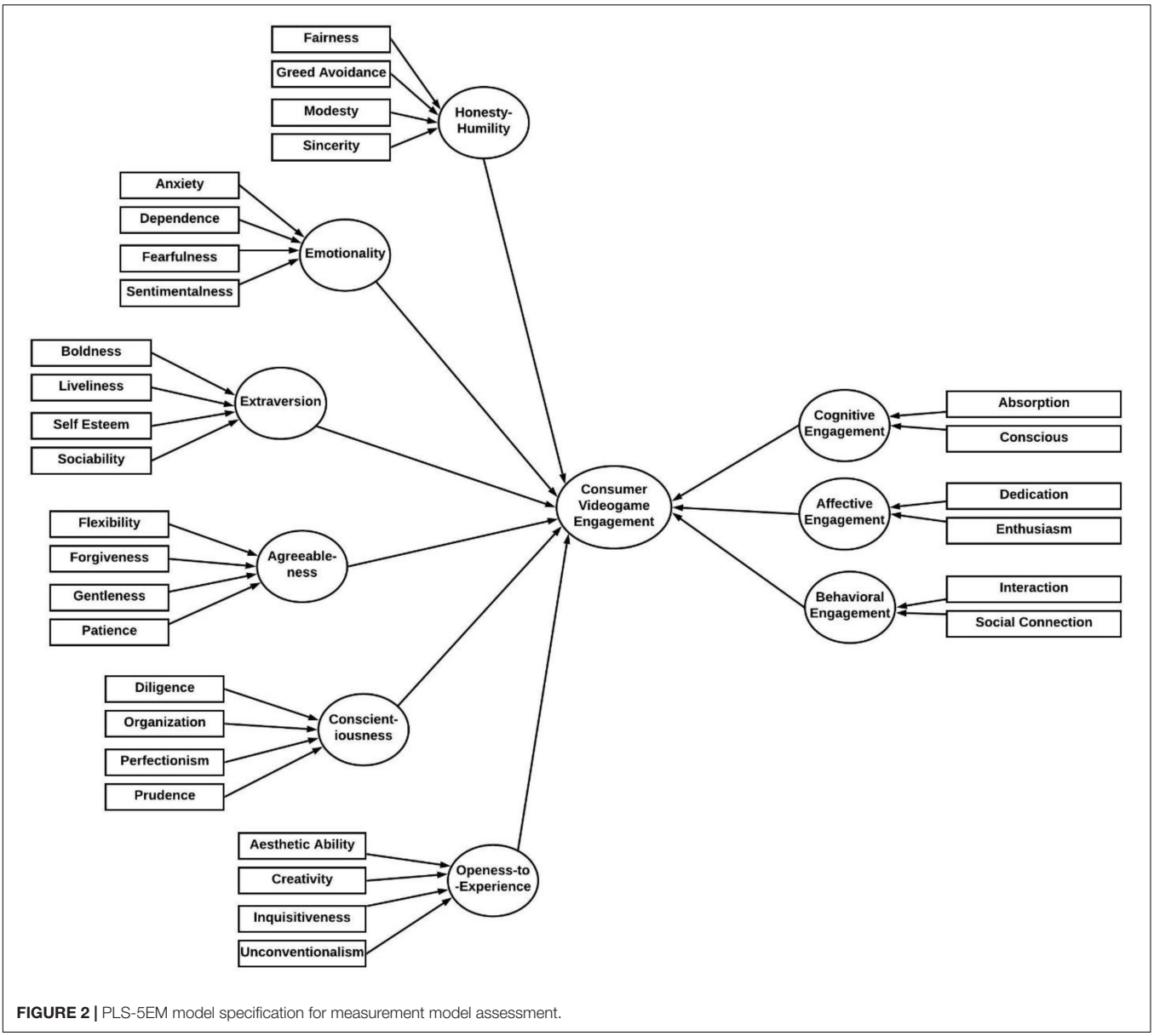

FIGURE 2 | PLS-5EM model specification for measurement model assessment.

by Kock (2017). Hair et al. (2011) also emphasized that the construct's weight and significance level must be assessed. The value of the significance level must be less than 0.05. **Table 4** reveals the significance or *P*-value of indicator weights associated with second-order formative constructs and VIF of the variables; these values in **Table 4** match the discussed threshold criteria. Hence, our second-order formative constructs are valid and reliable for further analysis (see **Table 4**).

Assessment of Third-Order/Higher-Order Formative Construct

Again, to assess the validity of the third-order construct, that is consumer video game engagement, the study used WarpPLS version 6.0. Initially, the value of VIF was assessed, and then the significance level of the indicator's weight was checked. **Table 5** shows the values of VIF, indicator weights, and their significance level. All the values of each construct have VIF below five, and associated indicator weights meet the significance level except the affective engagement. Under such situation, Hair et al. (2016) recommended to assess the outer loading of the item, and if the outer loadings exceed the value of 0.40, then we can keep an item. Following the guideline, we examined the outer loading for affective engagement and found that it exceeded the critical value of 0.40. Therefore, these values confirm the validity of the third-order formative construct also (see **Table 5**).

Step 2: Structural Model Assessment

The study used WarpPLS version 6.0 to check the framework model and hypotheses. For this, we assessed the value of path coefficient with effect size and *T*-value and the significance of the R^2 coefficient. Effect size measures the impact of the independent

TABLE 2 | Assessment of measurement model.

Scale	Items	Loadings	*P*-value	CR	Cronbach alpha	Avg. variance	VIF
Sincerity	Item1	0.860	<0.001	0.855	0.745	0.663	1.259
	Item2	0.768	<0.001				
	Item3	0.812	<0.001				
Fairness	Item1	0.820	<0.001	0.845	0.725	0.645	1.408
	Item2	0.775	<0.001				
	Item3	0.814	<0.001				
Greed Avoidance	Item1	0.865	<0.001	0.856	0.664	0.748	1.35
	Item2	0.865	<0.001				
Modesty	Item1	0.885	<0.001	0.879	0.724	0.784	1.192
	Item2	0.885	<0.001				
Fearfulness	Item1	0.972	<0.001	0.848	0.713	0.678	1.343
	Item2	0.971	<0.001				
	Item3	0.381	<0.001				
Anxiety	Item1	0.898	<0.001	0.893	0.759	0.806	1.266
	Item2	0.898	<0.001				
Dependence	Item1	0.887	<0.001	0.881	0.729	0.787	1.22
	Item2	0.887	<0.001				
Sentimentality	Item1	0.847	<0.001	0.851	0.737	0.657	1.244
	Item2	0.842	<0.001				
	Item3	0.738	<0.001				
Self esteem	Item1	0.787	<0.001	0.836	0.705	0.629	1.796
	Item2	0.822	<0.001				
	Item3	0.770	<0.001				
Social boldness	Item1	0.779	<0.001	0.859	0.753	0.67	1.857
	Item2	0.831	<0.001				
	Item3	0.844	<0.001				
Sociability	Item1	0.899	<0.001	0.894	0.762	0.808	0.2
	Item2	0.899	<0.001				
Liveliness	Item1	0.903	<0.001	0.898	0.773	0.815	1.628
	Item2	0.903	<0.001				
Forgiveness	Item1	0.880	<0.001	0.873	0.708	0.774	2.147
	Item2	0.880	<0.001				
Gentleness	Item1	0.741	<0.001	0.84	0.713	0.637	1.983
	Item2	0.847	<0.001				
	Item3	0.803	<0.001				
Flexibility	Item1	0.794	<0.001	0.836	0.705	0.629	2.078
	Item2	0.762	<0.001				
	Item3	0.822	<0.001				
Patience	Item1	0.885	<0.001	0.879	0.724	0.783	1.644
	Item2	0.885	<0.001				
Organization	Item1	0.889	<0.001	0.883	0.735	0.791	1.786
	Item2	0.889	<0.001				
Diligence	Item1	0.877	<0.001	0.869	0.7	0.769	1.759
	Item2	0.877	<0.001				
Perfectionism	Item1	0.731	<0.001	0.841	0.715	0.639	1.893
	Item2	0.814	<0.001				
	Item3	0.848	<0.001				
Prudence	Item1	0.816	<0.001	0.861	0.758	0.674	1.703
	Item2	0.833	<0.001				
	Item3	0.813	<0.001				
Aesthetic appreciation	Item1	0.904	<0.001	0.899	0.776	0.817	1.468
	Item2	0.904	<0.001				

(Continued)

TABLE 2 | Continued

Scale	Items	Loadings	*P*-value	CR	Cronbach alpha	Avg. variance	VIF
Inquisitiveness	Item1	0.894	<0.001	0.888	0.748	0.799	1.956
	Item2	0.894	<0.001				
Creativity	Item1	0.810	<0.001	0.836	0.704	0.63	1.714
	Item2	0.850	<0.001				
	Item3	0.715	<0.001				
Unconventionality	Item1	0.853	<0.001	0.846	0.727	0.648	1.446
	Item2	0.792	<0.001				
	Item3	0.767	<0.001				
Conscious attention	Item1	0.713	<0.001	0.883	0.841	0.558	3.052
	Item2	0.774	<0.001				
	Item3	0.763	<0.001				
	Item4	0.764	<0.001				
	Item5	0.756	<0.001				
	Item6	0.711	<0.001				
Absorption	Item1	0.737	<0.001	0.874	0.819	0.581	3.084
	Item2	0.774	<0.001				
	Item3	0.766	<0.001				
	Item4	0.751	<0.001				
	Item5	0.781	<0.001				
Dedication	Item1	0.873	<0.001	0.895	0.846	0.641	2.188
	Item2	0.885	<0.001				
	Item3	0.874	<0.001				
	Item4	0.435	<0.001				
	Item5	0.841	<0.001				
Enthusiasm	Item1	0.877	<0.001	0.901	0.834	0.752	2.321
	Item2	0.906	<0.001				
	Item3	0.815	<0.001				
Social connection	Item1	0.816	<0.001	0.863	0.762	0.677	2.424
	Item2	0.815	<0.001				
	Item3	0.837	<0.001				
Interaction	Item1	0.731	<0.001	0.884	0.836	0.604	3.313
	Item2	0.776	<0.001				
	Item3	0.801	<0.001				
	Item4	0.831	<0.001				
	Item5	0.743	<0.001				

variable on the dependent variable. According to the values of the effect size given in **Table 6**, we conclude the following:

- Players' honesty–humility and emotionality factors have no effect on predicting consumer video game engagement.
- In contrast, players' conscientiousness, openness to experience, agreeableness, and extraversion factors have more than a small effect on developing consumer video game engagement. Hence, our proposed hypotheses are accepted.

In addition to the effect size, we also calculated the *P*-value, *T*-value, and path coefficient for our study hypotheses. The results shown in **Table 6** illustrated that honesty–humility has an insignificant relationship with consumer video game engagement (path = 0.065; $T = 1.03$; $P = 0.15$) – H1 is not accepted. Furthermore, the path coefficient, *T*-value, and *P*-value for depicting the relationship between emotionality and consumer video game engagement are 0.07, 1.12, and 0.132, respectively. Because this does not meet the set criteria, our second hypothesis is also rejected. This means that there is no significant relationship between emotionality and consumer video game engagement – hence, H2 is not supported. Extraversion has a significant relationship with consumer video game engagement with a path coefficient of 0.145, *T*-value of 2.33, and *P*-value of 0.01—and as a result, H3 is accepted. Similarly, agreeableness, conscientiousness, and openness to experience have path coefficient values of 0.232, 0.184, and 0.177 and *T*-values of 3.8, 2.87, and 2.9, respectively. Also, the *P*-values shown in the table are < 0.001, 0.002, and 0.002 accordingly – therefore, H4, H5, and H6 are accepted. See **Table 6** and **Figure 3** for more details.

In addition, we examined the correlations between the personality traits, and the results showed that there is no high correlation issue. See **Table 7** for more details.

TABLE 3 | Discriminant validity.

	HSin	Hfair	Hgred	Efear	Eanxity	Edep	Esenti	Eslfest	Ebold	Esoc
HSin	**0.814**									
Hfair	0.201	**0.8**								
Hgreed	0.225	0.27	**0.865**							
Efearfu	0.173	0.21	0.229	**0.823**						
Enxity	0.129	0	0.201	0.187	**0.898**					
Edep	0.162	0.16	0.186	0.152	0.237	**0.887**				
Esent	0.058	0.02	0.222	0.071	0.238	0.173	**0.811**			
Eslfest	−0.03	0.09	−0.01	0.066	−0.053	0.062	0.077	**0.793**		
Ebold	0.065	0.16	0.074	0.155	0.091	0.141	0.143	0.471	**0.818**	
Esoc	0.09	0.1	0.099	0.196	0.114	0.011	0.134	0.428	0.45	**0.899**

	ELivli	Aforg	Agent	Aflex	Apat	Corg	Cdelg	Cperf	Cprud	Oaest	Oinqu
ELivli	**0.903**										
Aforgv	0.395	**0.88**									
Agentl	0.274	0.513	**0.798**								
Aflex	0.222	0.455	0.498	**0.793**							
Apatnc	0.202	0.425	0.36	0.455	**0.885**						
Corg	0.269	0.259	0.264	0.209	0.275	**0.889**					
Cdelig	0.206	0.263	0.123	0.19	0.333	0.456	**0.877**				
Cperf	0.217	0.261	0.226	0.316	0.338	0.469	0.447	**0.799**			
Cprud	0.177	0.136	0.133	0.352	0.261	0.316	0.304	0.428	**0.821**		
Oaesth	0.118	0.191	0.191	0.329	0.327	0.216	0.265	0.274	0.184	**0.904**	
Oinqu	0.402	0.419	0.402	0.377	0.419	0.292	0.314	0.397	0.256	0.392	**0.894**

	Creat	Unc	ConAt	Asorp	Dedic	Enthu	Socon	Interc
Creatit	**0.794**							
Uncon	0.29	**0.805**						
ConAte	0.298	0.239	**0.747**					
Asorp	0.327	0.14	0.65	**0.762**				
Dedic	0.248	0.189	0.575	0.643	**0.801**			
Enthu	0.283	0.162	0.598	0.619	0.559	**0.867**		
Socon	0.277	0.206	0.621	0.65	0.483	0.533	**0.823**	
Interac	0.306	0.224	0.701	0.652	0.642	0.688	0.637	**0.777**

Square roots of average variances extracted (AVEs) shown on diagonal.

DISCUSSION

With the addition of different gaming platforms, eSport video game is rapidly gaining prominence in the gaming industry. This study employs the HEXACO personality model to establish a relationship between consumer personality and consumer video game engagement in the context of eSports. Quantitative methods were employed in this research, and HEXACO-PI-R 60 items were used to investigate the personalities of consumers engaged in eSports. The study empirically tested and validated the proposed model using WarpPLS version 6.0 for SEM analysis. This research presents novel insights in uncovering the specific personality factors that drive consumers' video game engagement.

According to the data analysis, honesty–humility, and emotionality factors carry an insignificant impact on consumer video game engagement, whereas extraversion, agreeableness, consciousness, and openness to experience have a significant effect on consumer video game engagement.

As mentioned earlier, our first hypothesis indicates that honesty–humility has an insignificant impact on consumer video game engagement. Previously, Worth and Book (2014) also empirically tested this premise; they demonstrated that personalities covering the characteristic are less inclined to engage in player-versus-player–style games. Furthermore, games that involve profit manipulation, rule breaking, and material gain are also correlated with a low characteristic of honesty–humility (Andrus, 2018). Insignificant association of this attribute with consumer video game engagement is also demonstrated by Zeigler-Hill and Monica (2015). Games involve exploitation and strategic maneuvering, which can be less appealing for individuals who score high on honesty–humility.

Our second hypothesis revealed an insignificant relationship of emotionality with consumer video game engagement. In prior studies, a negative relationship was also confirmed between

TABLE 4 | Assessment of the measurement model on second-order formative constructs (e.g., honesty-humility, emotionality, and etc.).

Constructs	Items	Scale type	Weights	Sig	Full collinearity	VIF
Honesty-humility		Formative			1.153	
	Sincerity		0.452	<0.001		1.08
	Fairness		0.48	<0.001		1.136
	Greed avoidance		0.499	<0.001		1.134
Emotionality		Formative			1.166	
	Fearfulness		0.33	<0.001		1.05
	Anxiety		0.466	<0.001		1.132
	Dependence		0.42	<0.001		1.089
	Sentimentality		0.383	<0.001		1.077
Extraversion		Formative			1.7	
	Social self esteem		0.323	<0.001		1.402
	Social boldness		0.338	<0.001		1.473
	Sociability		0.346	<0.001		1.527
	Liveliness		0.317	<0.001		1.376
Agreeableness		Formative			2.007	
	Forgiveness		0.333	<0.001		1.545
	Gentleness		0.33	<0.001		1.552
	Flexibility		0.335	<0.001		1.557
	Patience		0.304	<0.001		1.372
Conscientiousness		Formative			1.526	
	Organization		0.343	<0.001		1.436
	Diligence		0.336	<0.001		1.398
	Perfectionism		0.361	<0.001		1.54
	Prudence		0.3	<0.001		1.263
Openness-to-experience		Formative			1.787	
	Aesthetic app		0.347	<0.001		1.286
	Inquisitiveness		0.373	<0.001		1.396
	Creativity		0.364	<0.001		1.361
	Unconventionality		0.303	<0.001		1.172
Cognitive engagement		Formative			3.470	
	Conscious attention		0.551	<0.001		1.731
	Absorption		0.551	<0.001		1.731
Affective engagement		Formative			2.673	
	Dedication		0.566	<0.001		1.454
	Enthusiasm		0.566	<0.001		1.454
Behavioral engagement		Formative			3.224	
	Social connection		0.553	<0.001		1.682
	Interaction		0.553	<0.001		1.682

TABLE 5 | Assessment of the measurement model of higher-order formative construct (consumer videogame engagement).

Constructs	Items	Scale type	Weights	Sig	Full Collinearity	VIF
Consumer VGE		Formative			1.549	
	Cognitive Eng		0.468	<0.001		3.360
	Affective Eng		0.072	0.125		2.644
	Behavioral Eng		0.526	<0.001		3.089

emotionality and daredevil preferences (Zeigler-Hill and Monica, 2015). It is important to highlight that emotional individuals prefer to avoid challenging scenarios where there is a likelihood to receive negative feedback and social disapproval. Furthermore, emotional individuals tend to demonstrate dour outlooks, which can aggravate in gaming contexts. Therefore, it is not surprising that emotionality factor does not indicate a positive association with consumer video game engagement.

Our third hypothesis of the study showed a positive relationship of extraversion with consumer video game engagement. Previous literature also confirms the presence of an insignificant relation in the context of player game preferences (Andrus, 2018), video game preferences (Zeigler-Hill and Monica, 2015), and game-playing style (Bean and Groth-Marnat, 2016). Generally, personalities that are social, optimistic, and confident actively engage in video games because gaming environments appeal to their individual psychosomatic inclinations.

Our fourth hypothesis shows a positive relationship between agreeableness and consumer video game engagement. In previous

TABLE 6 | Assessment of the structural model.

Hypothesis testing		Path coefficient	SE	F2	*T*-value	*P*-value	Result
H1: Honesty-humility	Con VGE	0.065	0.063	0.012	1.03	0.15	Not supported
H2: Emotionality	Con VGE	0.07	0.062	0.014	1.12	0.132	Not supported
H3: Extraversion	Con VGE	0.145	0.062	0.067	2.33	0.01	Supported
H4: Agreeableness	Con VGE	0.232	0.061	0.115	3.8	<0.001	Supported
H5: Conscientiousness	Con VGE	0.184	0.061	0.08	2.87	0.002	Supported
H6: Openness to Exp	Con VGE	0.177	0.061	0.084	2.9	0.002	Supported

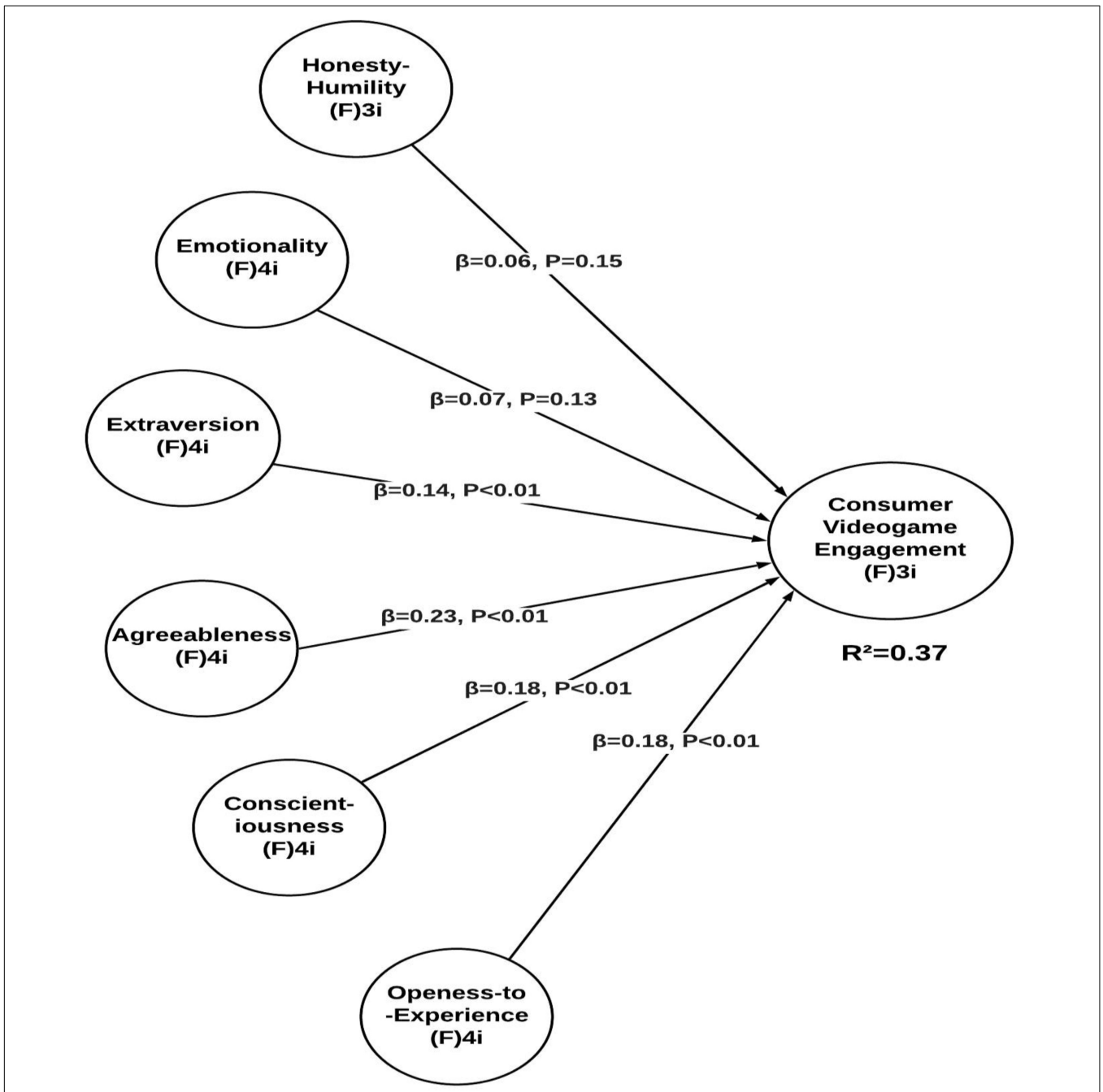

FIGURE 3 | Structural model assessment.

TABLE 7 | Correlations matrix using HEXACO 60-item English version.

	H	E	X	A	C	O
Honesty-humility	1					
Emotionality	0.324	1				
Extraversion	0.078	0.209	1			
Agreeableness	−0.033	0.121	0.580	1		
Conscientiousness	0.019	0.036	0.385	0.429	1	
Openness to experience	0.092	0.104	0.419	0.544	0.546	1

research, agreeableness dimension carries a positive correlation in multiplayer games environment and "helping" style games (Worth and Book, 2014), as well as a positive correlation with a preference to play challenging games (Zeigler-Hill and Monica, 2015). So, individuals with this attribute are adaptable and understanding and carry the proclivity to engage in games for social rapport or entertainment purposes actively.

Our fifth hypothesis shows that consciousness has a positive association with consumer video game engagement. In previous research, conscious individuals have demonstrated achievement-oriented behaviors in game-based settings (Zeigler-Hill and Monica, 2015). Zeigler-Hill and Monica (2015) have indicated that individuals with high consciousness scores prefer games that involve accomplishing arduous tasks or solving challenges rather than indulging in game play purely for leisure purposes. Therefore, from our study, we can conclude that well-organized, disciplined, and careful individuals prefer to invest time in experiencing different genres of thought-provoking games.

Our final hypothesis shows a positive relationship between openness to experience with consumer video game engagement. Literature confirms the same relationship: for instance, a study revealed that online-game players are higher in openness to experience than nonplayers (Teng, 2008). Also, openness to experience is associated with the gratification of play and shows the highest positive association for unique game behavior predilections (Bean and Groth-Marnat, 2016; Andrus, 2018). Therefore, we can say that individuals with openness to experience are eager to seek new information and are creative, imaginative, and adaptable; the presence of such psychographics results in a greater drive for engagement in video games.

IMPLICATIONS AND FURTHER RESEARCH

Theoretical Implications

This study makes several theoretical contributions. First, we present an empirical study of the HEXACO personality model and its association with consumer video game engagement in the context of eSports. Previous literature added that Big Five personality dimensions carry an impact on CE in the context of online brand communities such as social media platforms (Ul Islam et al., 2017). However, we extend the existing literature on personality traits, especially focusing on video game studies through investigating a novel model, that is, HEAXCO in the realm of consumer behavior and eSports settings. We demonstrate that certain dimensions of the HEXACO model contribute to driving CE in eSports. Second, this study also adds value to the current gaming research within the marketing literature. This research can aid researchers and marketers that are interested in analyzing empirical work that investigates CE with the video game industry. Third, we advance the earlier studies on personality traits through applying the hierarchical component model approach (Becker et al., 2012; Sarstedt et al., 2019) to establish and validate higher-order constructs. Fourth, we contribute to the notion of consumer video game engagement as we provide the evidence that personality traits do impact on CE in eSports context.

Managerial Implications

This study also makes critical managerial contributions. First, this article highlights how marketers can capitalize on consumers' personality factors by focusing their investments on specific personality attributes that are predicted to optimize video game engagement. Secondly, our model offers marketing practitioners the opportunity to develop video game strategies based on their target consumers' personality factors and their expected effect on CE, which are extremely substantial in today's era of one-to-one marketing and big data analytics. Third, video game developers can also develop specific games by capturing consumer's interest according to each personality factor; thus, ultimately, their market share and overall growth in the industry can be maximized. A clearer picture of consumers' personality characteristics may also help practitioners garner a better understanding of how to strategically build a process to engage customers in video game settings actively.

Future Research

Despite its contributions, this study is still in its exploratory stage to understand the personality factors and consumer video game engagement and therefore subjected to several limitations. The first limitation is on the assumption that gamers and eSport gamers are assumed to take on the role as what is observed. With the six attributes that we have identified, we have taken the eSport gamers and personalities on the face value. We believe that it is also important to understand what takes place throughout the development of the attitude and behavior of these gamers. This could be done by using a longitudinal study (development of behavior through a process of sampling different sample groups) or conducting an experiment on the personality traits that are captured in the HEXACO 60 items. In experimental studies, control groups should be able to mobilize to capture the effects of the personalities. Second, to validate the HEXACO 60 items, the sample size is relatively small and focused on respondents from Pakistan. For a better generalization, there should be efforts to collect more samples, not only within a country but also to simultaneously expand the data collection to different countries (to capture the differences in cultures as well). Third, our study is limited in terms of the scope of its investigation within the context of eSports, whereas this study can also be extended to other genres of video games including intellectual games or virtual reality

games and to investigate how consumers' personality characteristics predict consumers' preferred game-product preferences. Fourthly, with the advent of eSport gaming, games are not only played by men, but also by women. We acknowledge the unbalanced gender distribution in our study. Care should be taken to include a better representation of gender distribution in future studies. The condition of nongamers versus gamers (or occasional gamers) should also be defined, to understand and capture the unprecedented conditions and personality differences.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Departmental Ethical Review Committee Shaheed Zulfikar Ali Bhutto Institute of Science and Technology (Szabist). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AA, SN, and UR worked on the idea development and conceptual design. SN and AA worked on the data analyses. SN, UR, AA, and DT edited the manuscript and improved the contents of the manuscript. All authors contributed to the article and approved the submitted version.

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Personalizing Human-Agent Interaction Through Cognitive Models

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Cognitive modeling of human behavior has advanced the understanding of underlying processes in several domains of psychology and cognitive science. In this article, we outline how we expect cognitive modeling to improve comprehension of individual cognitive processes in human-agent interaction and, particularly, human-robot interaction (HRI). We argue that cognitive models offer advantages compared to data-analytical models, specifically for research questions with expressed interest in theories of cognitive functions. However, the implementation of cognitive models is arguably more complex than common statistical procedures. Additionally, cognitive modeling paradigms typically have an explicit commitment to an underlying computational theory. We propose a conceptual framework for designing cognitive models that aims to identify whether the use of cognitive modeling is applicable to a given research question. The framework consists of five external and internal aspects related to the modeling process: research question, level of analysis, modeling paradigms, computational properties, and iterative model development. In addition to deriving our framework from a concise literature analysis, we discuss challenges and potentials of cognitive modeling. We expect cognitive models to leverage personalized human behavior prediction, agent behavior generation, and interaction pretraining as well as adaptation, which we outline with application examples from personalized HRI.

Keywords: personalization, cognitive modeling, human-agent interaction, behavior prediction/generation, interaction adaption

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INTRODUCTION

Contemporary approaches highlight the relevance of personalization in human-agent interaction (HAI). For example, e-commerce applications that use web personalization to create product deals and recommendations for users traditionally enjoy persistent research interest (Salonen and Karjaluoto, 2016). However, personalization has also long since branched out from e-commerce to further areas of human-computer interaction (HCI), such as activity recognition (Sztyler and Stuckenschmidt, 2017; Zunino et al., 2017; Siirtola et al., 2019), body part tracking (Tkach et al., 2017), assisted driving (Hasenjäger and Wersing, 2017), and human-robot interaction (HRI; Clabaugh and Matarić, 2018; Collins, 2019; Irfan et al., 2019). Although user experience of personalized services is positively influenced by overtness and transparency (Chen and Sundar, 2018; Dolin et al., 2018), personalization is not universally appreciated due to concerns

over users' loss of information privacy (Alatalo and Siponen, 2001; Chellappa and Sin, 2005; Awad and Krishnan, 2006; Schneider et al., 2017; Ku et al., 2018).

As Graus and Ferwerda (2019) argue, personalization is typically achieved by a system adapting to data-driven inference about users based on their previous behaviors. Their study posits that a theoretically motivated approach may lead to two benefits over a purely data-driven model: reducing the need for extensive data analysis and potentially generating new insight regarding the appropriateness of a given theory. The sentiment for more theory-driven approaches in data analysis is also shared by Plonsky et al. (2019) and Bourgin et al. (2019). Both articles highlight the improved prediction of human decisions by machine learning models after implementing variants of behaviorally relevant psychological theories. Bourgin et al. (2019) specifically make the case for pretraining machine learning models with data simulated by cognitive models. Cognitive models refer to the instantiation of a theory that relates to one or more cognitive functions and tries computationally to replicate them. Due to this, cognitive modeling is routinely used synonymously with computational modeling (Sun, 2008a). In previous research, the application of cognitive models has helped to explain or recontextualize several empirically established psychological phenomena (Adams, 2007; Körding et al., 2007; Vul et al., 2014; Srivastava and Vul, 2017). It is routinely argued that the advantage of cognitive models over, for example, verbal-conceptual or data-driven statistical models lie in the need to translate a theoretical framework into a computational system, leaving less freedom for interpretation (Sun, 2008a; Stafford, 2009; Murphy, 2011; Farkaš, 2012). In contrast to cognitive models, verbal-conceptual models define no formal relationship between concepts in a mathematical sense, and statistical models use mathematical equations to describe the relationship between concepts but do not require the translation into a computational system. Sun (2008a) notes that statistical models "may be viewed as a subset of computational models, as normally they can readily lead to computational implementations […]."

As Plonsky et al. (2019) and Bourgin et al. (2019) show, involving cognitive models in human behavior prediction as outlined in **Figure 1** increases predictive performance. It is reasonable to assume that a similar performance increase can be expected by incorporating cognitive models into the data-analytic inference required for personalization (Graus and Ferwerda, 2019) and in (personalized) HRI (Collins, 2019; Cross et al., 2019; Fischer and Demiris, 2019; Prescott et al., 2019). Following from this, this article discusses challenges and potentials of cognitive models focusing on user-specific effects and proposes a conceptual framework for (personalized) model development in Section "A Conceptual Framework for Designing Cognitive Models." Subsequently, we discuss the HRI application examples from **Figure 1** in detail and analyze common pitfalls in Section "Application Examples and Pitfalls." Section "Conclusion" concludes by discussing connections of personalization and cognitive modeling and outlining directions for future research.

A CONCEPTUAL FRAMEWORK FOR DESIGNING COGNITIVE MODELS

We present a conceptual framework to consider model-related and external aspects when designing cognitive models, following the definition of conceptual frameworks given by Imenda (2014). As an inductive synthesis of existing theoretical and empirical insights, the proposed framework highlights important considerations with regard to cognitive modeling, specifically for researchers new to the method. **Figure 2** provides a schematic representation of the framework components and their interactions, which are presented and discussed in the remainder of the paper. Researchers applying the framework start by evaluating the domain suitability of the research question and make a cost-benefit decision based on the suitability and available

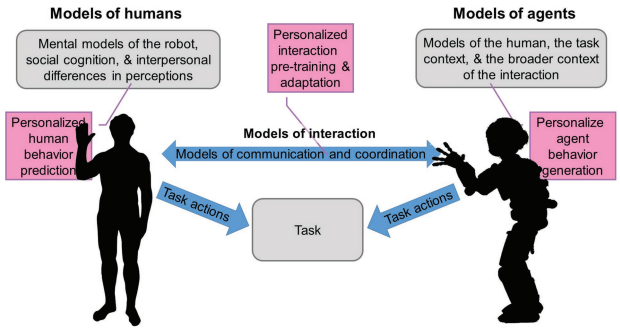

FIGURE 1 | Cognitive human-robot interaction (HRI) as presented and discussed by Mutlu et al. (2016) as an example of human-agent interaction (HAI) (blue and gray). Various interaction challenges might be tackled applying cognitive models and exhibit strong potential for personalization (magenta). For instance, human behavior prediction (models of humans), interaction pretraining and adaptation (models of coordination), and generating agent behavior from human models (models of agents).

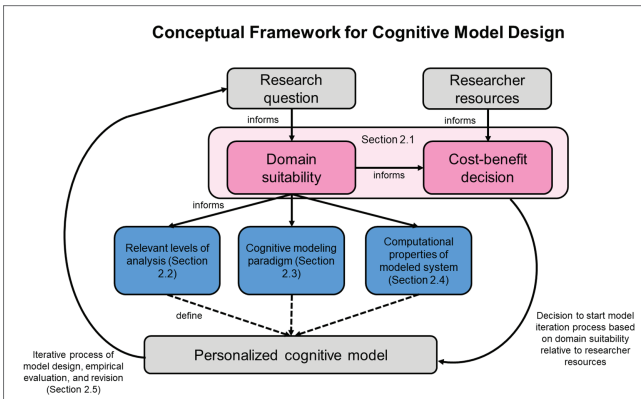

FIGURE 2 | Conceptual framework for cognitive model design. External aspects are displayed in gray, and pink indicates initial considerations that inform the specific design decisions, which are themselves colored blue. The framework is used by evaluating domain suitability and available resources to reach a decision on whether to initiate the modeling process. Then, model-related aspects are defined and the resulting model is empirically evaluated. If necessary, an iterative process of model improvement is started.

resources. Given a positive evaluation, they define the model-related aspects that constrain the actual cognitive model. Based on the model's performance in predicting empirical data, there may be a need to revise the model design and evaluate again or use the available model to investigate the research question.

Research Questions and Resources

An initial threshold regarding the application of cognitive models is the considered research question, i.e., questions related to cognitive functions. Sun (2008a) identifies several cognitive functions that can be approached by cognitive modeling: motivation, emotion, perception, categorization, memory, decision making, reasoning, planning, problem-solving, motor control, learning, metacognition, language, and communication. If included in a theory, these cognitive functions may suggest a computational view toward human behavior and may, therefore, benefit from cognitive modeling. Because many other types of models lack the precision derived from formalized model definition (Murphy, 2011), cognitive models can help to understand the functions suggested by Sun (2008a). The aforementioned cognitive functions develop highly interindividually, and cognitive states in a given situation are difficult to generalize. Therefore, Lee (2011) highlights the importance of accounting for individual differences in the execution of cognitive functions and proposes hierarchical cognitive modeling as a way to do so. Using cognitive models to estimate and then maintain a representation of the motivational, emotional, or other cognitive states of individuals allows an interactive system to adjust its behavior and, accordingly, may help to personalize user experience with HAI systems (Schürmann et al., 2019). It is still debated whether statistical or verbal-conceptual models (Sun, 2008a; Çelikok et al., 2019; Guest and Martin, 2020) provide the required conceptual precision to shed light on the underlying theory. In our opinion, the application of cognitive modeling is less beneficial for research questions that do not directly deal with the cognitive functions mentioned above or research questions that lack established assumptions about how these cognitive functions work. As depicted in **Figure 2**, the suitability of cognitive modeling is determined based on the related cognitive functions.

A second important requirement of applying cognitive modeling relates to resources available to the researcher, e.g., programming capabilities. To our knowledge, there is no software solution available that allows for cognitive modeling design without programming expertise. As Addyman and French (2012) point out, even simulation environments such as ACT-R (Ritter et al., 2019) are often of little use to researchers without programming experience. Although most programming languages should be capable of the required mathematical operations, high-level languages focusing on statistics and providing function libraries, e.g., R, Python or Matlab, can strongly simplify cognitive modeling. In our framework, programming resources and the suitability of the research question inform a cost-benefit decision that indicates whether the development of a cognitive model should be started (see **Figure 2**).

Relevant Levels of Analysis

Marr (1982) defines three levels of analysis on which the study of cognitive systems is most commonly based. These levels do not fall into a strict hierarchy but can be understood as complementary descriptions of a cognitive system from equally important perspectives. The first step when applying our framework is to clarify to which levels of analysis the cognitive model in question may be connected (left path in **Figure 2**). Answering this question provides the researcher with constraints for further modeling steps. The computational level includes the content of computations that a cognitive system, irrespective of being human or artificial, executes. This includes the logic and structure of the problem or task that a cognitive system attempts to solve. The algorithmic level contains information about the processes and representations that describe the computation. Last, the implementational level deals with the biological or artificial realization in physical hardware. Zednik and Jakel (2014) paraphrase this categorization of levels of analysis; the computational level specifies what a system is doing and why it is doing it; the algorithmic level specifies the how; and the implementational level specifies the where. Over time, researchers have suggested adding layers to the levels of analysis (Griffiths et al., 2015) or adjusting models so that they are defined on more than one level of analysis (Griffiths et al., 2012; Vul et al., 2014).

Applying cognitive modeling to a given research question includes identifying the levels of analysis that are most relevant or applicable, i.e., which level of analysis is required to describe the given problem. For example, Griffiths et al. (2008) argue that Bayesian cognitive modeling is more suitable for problems of inductive inference than for predicting human behavior due to the mathematical structure of Bayes' rule. Outlining the scope of the problem that the cognitive system is expected to solve leads, in the authors' experience, to an intuitive restriction of applicable levels of analysis. If one can assume that all individuals solve the same cognitive problem, the level of analysis chosen is not something to be personalized but rather a modeling choice that determines the possible dimensions of personalization in subsequent steps.

Selection of Cognitive Modeling Paradigms

Considering the identified cognitive problem, several modeling paradigms may present themselves, each with their own potential for personalization. These candidate paradigms are routinely, but not necessarily, defined on the same level of analysis (Marr, 1982) as the cognitive problem they approach. One could argue that the more levels covered by a model's predictions, the more complete the understanding of a phenomenon is. For example, instead of providing a predicted response to a choice problem, a model can also provide an estimate of predicted reaction time required to respond to the choice problem. Although covering multiple levels has the potential to provide new insights, a research question may not yet include any reasonable assumptions about reaction times so that the required additional specifications of a prediction time model could be theoretically under-constrained. Additionally, covering Marr's levels completely may not be necessary for all research problems; e.g., cognitive algorithms might be powerful extensions to existing robotic platforms.

Depending on the relation to cognitive functions and levels of analysis (Marr, 1982), an appropriate cognitive modeling

paradigm should be selected (middle path in **Figure 2**). Sun (2008b) identifies the following paradigms: connectionism, Bayesianism, dynamical systems approaches, declarative or logic-based models, and cognitive architectures. All these paradigms allow for free parameters that govern individual model behavior and, hence, allow for personalization by parameter fitting. Moreover, the paradigms have soft boundaries, and mathematical representations of specific cognitive processes overlap (Roe et al., 2001; Fard et al., 2017). The number of free parameters in cognitive models can, however, cause overfitting as discussed in Section "Application Examples and Pitfalls." Therefore, we advise readers to approach the selection of cognitive modeling paradigms driven by their research question's underlying theory: Assuming interest in whether human choices satisfy criteria of rationality, juxtaposing a Bayesian model as a proxy for computational rationality against a heuristic model of violations against computational rationality is a suitable approach. As another example, a research question could concern specific neurological processes and, therefore, be compatible with modeling paradigms with an extension to implementational level of Marr (1982), i.e., the neural hardware.

Computational Properties of the Modeled System

As previously outlined, there are no general indications to select modeling paradigms or covering levels of analysis (Marr, 1982). Therefore, it appears suitable to consider the required computational properties to adequately account for the modeled behavior. This consideration is captured in the third path of our framework (right path in **Figure 2**). Calder et al. (2018) outline some computational properties: deterministic and nondeterministic (representing behavior by probabilities) models, static and dynamic (representing temporal effects) models, discrete or continuous models, and models based on individuals or populations. If a model is deterministic, it always produces the same behavior given the same input, and a nondeterministic model produces the behavior based on an internal probability. A static model has no inherent concept of time, and a dynamic one does. Discrete models represent their components in steps or levels, and continuous models use representations that are smooth. We posit that, as different models can be used to describe the same human behavior, they likely share similar properties. For HAI research, we assume that individual-focused models that are nondeterministic in nature to represent the probabilistic aspects of human choice and perception (Körding et al., 2007; Rieskamp, 2008) appear beneficial to provide accurate predictions of the target behavior. If the behavior of interest is human choice and perception, we consider the focus on individuals and non-determinism as necessary properties of a model. Whether a model operates discretely or continuously and whether it is static or dynamic may depend on the research question or cognitive function.

A principled way of drawing inference about a cognitive model's parameters on intra- and inter-individual levels comes in the form of hierarchical cognitive modeling (Lee, 2011). Once required computational properties have been defined, this hierarchical approach considers an individual's model parameters to be sampled from a population-wide distribution of parameters. In this way, both inter- and intra-individual variations in the behavior of human users can be respected by HAI systems with hierarchical modeling levels, thus allowing for personalization of the cognitive model.

Iterative Model Development, Evaluation, and Revision

Our proposed framework considers the external aspects, and settling on specific decisions regarding model development should result in a functioning and testable cognitive model. Evaluating the resulting model against empirical evidence or competing models, however, may show a gap between model predictions and observed behavior, depending on the specific nature of the research question. This suggests an iterative process of model development, evaluation, and revision, which provides the opportunity to reassess whether a specific combination of levels of analysis, modeling paradigm, and computational properties suits the research question. Murphy (2011) highlights that certain aspects of human behavior might not be understood well enough to justify using a formalized theory and a cognitive model building on said theory. However, an indication of whether we know enough or not is the repeated reference to formalized theories of cognitive functions in the literature. An applied example of this can be found in research about human user behavior in online services. Schürmann et al. (2020) conduct a secondary literature review in which they reanalyze existing review data concerning the frequency of references to computational-level theories, the frequency of interpretations of statistical model results as computational, and the frequency of actual computational implementations. References to formalized theories are found in 44.2% of the investigated literature, and results of statistical models are interpreted in a computational manner in 33.3% of cases. However, the prevalence of cognitive modeling implementations is low at 5% (Schürmann et al., 2020). Accordingly, it seems that information is sufficient to warrant statements about the cognitive functions of online users. An iterative model development process can then close in on suitable specifications such as the level(s) of analysis, modeling paradigm, and computational properties required to adequately describe a target behavior. To implement personalization, the formalization of inter-individual differences appears necessary. Although these could be represented as parameter differences in statistical models (Sun, 2008b) as well, cognitive models are potentially leading to improved understanding and theories of cognitive functions.

APPLICATION EXAMPLES AND PITFALLS

Before highlighting application examples and pitfalls of cognitive modeling in HAI with regard to personalization, it is necessary to define applications of cognitive models. We differentiate between three applications of cognitive models as outlined in **Figure 1**: (1) using models of human agents to understand decisional or perceptual processes to improve predictions of

the agent's behavior, (2) modeling human behavior to pretrain and adapt interaction, e.g., to monitor users' preferences, and (3) generating behavior of an artificial agent based on a cognitive model of human behavior.

The agent of interest may be a humanoid robot, a chat bot, or any type of system that might benefit from generating its own behavior in a human-like manner. In the remainder of this section, we focus on interaction between humans and humanoid robots as shown in **Figure 1** because we deem it a striking and very graspable exemplary case. Here, robotic agents may use cognitive models to predict human interactions, but they may also control their own sensorimotor behavior by use of such a cognitive model. The benefit of applying cognitive approaches lies in the potentially realistic imitation of human behavior and can foster both psychological research and the development of humanoid robots (Asada et al., 2009; Hoffmann et al., 2010; Schillaci et al., 2016; Prescott et al., 2019; Schürmann et al., 2019). Through fitting free parameters to interindividual differences, behavior prediction and generation can be personalized rather straightforwardly. Combining the idea of human and robot models with the approach of Bourgin et al. (2019) to pretrain contemporary machine learning models with cognitive models, we argue that humanoid robots could produce more human-like sensorimotor behavior that fosters interaction and adapts to the human partner. Considering the example of a human-robot handshake, cognitive models could be used to predict a user's movement selection (behavior prediction) and control the humanoid's motion execution (behavior generation) and also to align the robot's actions to the human partner, spatially and temporally (interaction adaptation; Wang et al., 2013; Vogt et al., 2017).

Pitfalls of applying cognitive models to HAI are generally similar to other domains. The advantage of higher formalization and predictive precision comes at the price of having to communicate programming-related and mathematical concepts to audiences that may be used to verbal-conceptual theories. Additionally, development, maintenance, and publication of model code represent considerable challenges compared to less computationally sophisticated methods. When programming a model, researchers need to be aware of the relation between the number of free parameters in a model and the danger of overfitting (Farrell and Lewandowsky, 2018). Specifically, within the context of personalization, the danger of overfitting individual differences lies in the loss of generalization so that the prediction of new, previously unseen users would be initially poor. Recently, researchers have noted that cognitive models run the risk of having fundamental aspects adjusted after empirical data have been observed for the purpose of increasing the fit to the data (Lee et al., 2019). This pitfall should be given special consideration when applying cognitive models to scenarios of personalization.

CONCLUSION

Cognitive modeling has strong potential in general and personalized HAI. We recommend considering the given conditions, especially whether the interactive task deals with the inter-individual aspects of cognitive functions. The conceptual framework proposed in this article helps to determine which cognitive function is of relevance and which cognitive modeling paradigm satisfies the required computational properties and serves for personalization as well as whether formal theories of cognition exist. Moreover, using the framework in HAI systems may help to discern whether a cognitive model could be used to predict human behavior, to pretrain and adapt interaction, and/or to generate the behavior of an artificial agent in a personalized fashion (see **Figure 1**).

Although not too commonly used, personalized HAI can be realized with many contemporary modeling paradigms through fitting free parameters or even online adaptation of model structures. We outline conditions that, when met, put cognitive modeling in a strong position to provide insights that cannot be provided by otherwise prominent statistical models. As Graus and Ferwerda (2019) suggest, theory-driven models benefit from a reduced need for extensive data analysis. Whether this holds true for cognitive models, which are notorious for their quickly rising number of free parameters, remains to be seen. As a second benefit, the generation of new insights seems particularly important with respect to cognitive models. Aside from theory-driven personalization, an added value of cognitive modeling in HAI stems from its practical application, e.g., in humanoid robot development. Here, improvement of the interaction with particular human users would not only result directly from the representation of inter-individual differences, but also from a general approximation of human behavior. First, human-like, e.g., less precise but more versatile, robot movements have been shown to improve the perceived interaction quality (Pan et al., 2019). Second, cognitive modeling has been successfully used for pretraining machine learning models (Bourgin et al., 2019), which increases learning efficiency and has strong potential to foster distinct progress in personalizing interaction.

Applying the proposed framework can clarify the relation between external and internal aspects of cognitive modeling and, especially, support first-time users. Future research should elaborate the conceptual framework in empirical HAI studies; focusing the purposes outlined in **Figure 1** will help to improve personalized interaction.

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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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Technology Acceptance, Technological Self-Efficacy, and Attitude Toward Technology-Based Self-Directed Learning: Learning Motivation as a Mediator

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This study explored the contribution of technology acceptance and technological self-efficacy to attitude toward technology-based self-directed learning in a sample of Chinese undergraduate students. The study also inquired into whether learning motivation mediated these associations. A total of 332 undergraduate students of college English course were enrolled to participate in questionnaires regarding their technology acceptance, technological self-efficacy, attitude toward technology-based self-directed learning, and learning motivation. Results indicated that students' technology acceptance and technological self-efficacy were related to their attitude toward technology-based self-directed learning. The findings also indicated that learning motivation mediated the relations of technology acceptance, technological self-efficacy, and attitude toward technology-based self-directed learning. Specifically, students experiencing greater technology acceptance and technological self-efficacy showed higher attitude toward technology-based self-directed learning. This study highlighted the significance of learning motivation as a mediating mechanism illustrating relations between students' perception of technology environments and their attitude toward technology-based self-directed learning.

Keywords: technology acceptance, technological self-efficacy, attitude, self-directed learning, learning motivation, English language learning

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INTRODUCTION

In the wake of network technology, online learning, e-learning, and other informal learning approaches expand resources, venues, and learning spaces, enabling self-initiated construction of learning experience (Lai and Gu, 2011; Reinders and White, 2011). By accessing to the ecology of language learning constructed by technological facilitating conditions, language learners can launch their learning on the basis of their own interests and needs. Thereby, it is indispensable that language learners are equipped with the competence to engage in technology-based self-directed learning (Benson and Reinders, 2011; Reinders and Darasawang, 2012).

Researchers have found that undergraduate students do adopt technology for learning (Inozu et al., 2010), but their use of technologies often lacks sufficient effectiveness (Kennedy and Miceli, 2010). Some studies have inquired into a few factors that affect students' utilization of technology for learning, including competency in technology use (Kennedy et al., 2008), perceived usefulness of technology (Goodyear and Ellis, 2008; Teo, 2011), perception of the utility of technological resources (Clark et al., 2009), and the scaffolding available in supporting the technology-enhanced learning experience (McLoughlin and Lee, 2010). According to Teo et al. (2015, p.78), "attitude toward technology use has been examined in various models that attempt to explain individuals' intention for technology use, including Technology Acceptance Model (TAM; Davis et al., 1989), TAM2 (Venkatesh and Davis, 2000), and Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003)." These studies underscore the importance of understanding of how personal attitude contributes to behavioral intention on technology use. However, there are comparatively few studies of the current literature that elaborate attitudes toward technology use. As such, Tate et al. (2015) posed the concern that current theories are deficient in constructs that could better annotate students' behavioral intention on technology use from the perspective of attitude. In this study, the author considered enhancing our understanding of the influences that students' personal characteristics would have on their behavioral intention on technology use. Additionally, confining the understanding only to technology-related factors may thwart a deeper understanding of what influences students' adopting technology for self-directed learning. Thus, examining this issue by supplementing the variable of learning motivation, this study is expected to add a new perspective to the existing research. Specifically, this study intended to inquire into how technology acceptance and technological self-efficacy contribute to attitude toward technology-based self-directed learning and meanwhile to investigate whether learning motivation mediated these associations in a sample of Chinese undergraduate students studying for college English course.

LITERATURE REVIEW

Technology Acceptance and Technological Self-Efficacy

The TAM was first proposed by Davis (1989) on the basis of the theory of reasoned action (TRA) advanced by Fishbein and Ajzen (1975), which is used to explain the associations between the students' technology acceptance of computer system, behavioral intention, and definite behavior of technology use. Davis (1989) believed that perceived usefulness and ease of use, as antecedent variables, constitute fundamental determinants of users' technology acceptance and thus affect their actual usage behavior (Teo and van Schaik, 2012). Venkatesh et al. (2003) expanded the TAM with empirical research by adding such factors as social influence, cognitive structure, and experience and the factor of subjective norm that had not been adopted in the original TAM. Using this theory and analysis method, later in the educational landscape, there were studies that verified and explained the intention of students' technology use (Teo, 2011) and the research of students' independent use of technology for language learning (Lai, 2013), etc. These studies are the concrete applications of TAM in empirical research. As such, in the educational field, technology acceptance is considered as a prerequisite for learners to adopt information technology to promote learning (Hsieh et al., 2017). Previous studies have discussed learners' acceptance of different types of technology, such as mobile technology (Pindeh et al., 2016; Nikou and Economides, 2017), computer-based communication technology (Park et al., 2014), social media (Hsieh et al., 2017), and MOOCS courses (Joo et al., 2018). In the technology-supported language learning environment, learners' perception and acceptance of emerging technologies are important factors that affect their effective learning (McLoughlin and Lee, 2010; Huang and Liaw, 2018) and also one of the core factors that affect self-directed learning (Liaw et al., 2007). Additionally, research on learners' technology acceptance needs to consider the impact of specific disciplines and social and cultural backgrounds on technology acceptance (Scherer et al., 2019). Related studies also explored the relationship between learners' technology acceptance and other variables, such as the relationship between technology acceptance and research constructs such as self-regulated learning, self-efficacy, and learning anxiety (Cho and Kim, 2013; Lai, 2013). Liaw and Huang (2013) conducted a relatively successful theoretical innovation by integrating TAM and self-regulated learning theory, revealing the structural relationship between learners' perceived usefulness, satisfaction, and self-regulated learning.

For many years, Fishbein and Ajzen's TRA has been conceived as an intentional behavior model for the study of individual behavior associated with information technology. However, Ajzen expanded the explanatory power of TRA in 1991, by adding a new construct of perceived behavioral control, which developed into the theory of planned behavior. In the context of technology-based behavior, several meta-analyses have found a good correlation between individual's perceived behavioral control and the usefulness of specific technology. Lai (2013) conceptualized perceived behavioral control as "people's perceptions of their ability and the availability of the support necessary to achieve an expected behavior" (p. 103). Among the widely used, multidimentional constructs of perceived behavioral control, technological self-efficacy was considered as the dominant determinant of the intention of using the technology (Teo, 2009; Teo and van Schaik, 2012). In this study, technological self-efficacy is characterized as students' perception of their capabilities to utilize technology-related tools and sites to conduct learning behaviors so as to achieve intended learning outcome (Bandura, 1997; Keengwe, 2007). Researchers have verified a significant positive influence of technological self-efficacy on technology acceptance and utilization (Celik and Yesilyurt, 2013) and regarded technological self-efficacy as a proxy of individuals'

control beliefs in technology use (Venkatesh and Davis, 1996). Researchers have also found that technological self-efficacy significantly affects students' behavioral preferences to use technological tools and their perceptions of the usefulness of technology for learning (Keengwe, 2007; Mew and Honey, 2010). Additionally, Ajzen (2002) decomposed the constructs of perceived behavioral control into two components: controllability and learning motivation. The concept of controllability essentially resembles technological self-efficacy, with both used as a proxy of individuals' control beliefs in technology use (Venkatesh and Davis,1996), whereas learning motivation means the individual's judgment of the ability to attain designated types of performance (Bandura, 1986). In the process of technology-based self-directed learning, students' technological learning motivation is reflected in their mastery and familiarity of technical skills, as is consistent with the study from Mew and Honey (2010), which indicated that technological learning motivation significantly influences students' intention to use online learning websites, technology-related facilities and their personal technology application. This study conceptualized the technology acceptance and technological learning motivation as supportive and fair. Technology acceptance reflects students' perceptions that technology is useful and easy to use, and thus they are interested in using it for self-directed learning (Lai, 2013).

Attitude Toward Technology-Based Self-Directed Learning

The concept of self-directed learning was defined by Knowles (1975) as "a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes"(p.18). The research tradition on self-directed learning emphasized learners' sense of personal autonomy of holding their learning objectives and assuming ownership of learning (Garrison, 1997; Knowles et al., 2015). For instance, Garrison (1997, p. 18) considered self-directed learning as "an approach where learners are motivated to assume personal responsibility and collaborative control of the cognitive (self-monitoring) and contextual (self-management) processes in constructing and confirming meaningful and worthwhile learning outcomes." Moreover, studies point to the importance of regarding learners as undertaking self-initiated learning activities (Benson and Reinders, 2011; Reinders and White, 2011). Additionally, a lot of studies on self-directed learning incorporated the dimensions of learning process, which highlighted cognitive and motivational constructs (Garrison, 2003), as well as the learning context and its impact on self-directed learning experiences (Song and Hill, 2007). This is particularly relevant when treating self-directed learning as occurring in a multifaceted and multiple contexts. In the pace of network communication technology, the research on self-directed learning in open educational resource repositories *via* the use of information technology and the Internet (such as MOOCs and online courses) has also received great concern (Kim et al., 2019). Nevertheless, some researchers identified that learners' active use of technology for language learning does not necessarily guarantee satisfactory outcomes (Lai and Gu, 2011) and does not really reflect a sound understanding of their effective use (Oxford, 2009; Kennedy and Miceli, 2010). Therefore, on the one hand, some external factors, such as computer literacy, technological facilitating conditions, have been viewed as a prerequisite for learners' effective use of technology (Hubbard and Romeo, 2012); on the other hand, learners' willingness to engage in technology use for self-directed learning has been highlighted ((Kop and Fournier, 2011). Some educational research intended to enhance self-directed learning incorporated multifaceted components that predict learners' active engagement in technology use. Attitude was argued to be very relevant to students' voluntary utilization of technology for learning (Saadé and Galloway, 2005). For instance, Lai (2013, p. 115) examined "three major attitudinal factors that drove the participants' willingness to use technology for language learning: intended learning effort, perceived usefulness of technology for language learning, and perceived educational compatibility of technology with language learning needs and preferences."

Previous studies (e.g., Teo, 2011; Teo and Wong, 2013) highlighted that students' beliefs on the utility of technology influenced attitude toward technology use. While attitude toward technology use was regarded as an individuals' overall affective response to using technology system, representing individual's emotional experience associated with technology use (Venkatesh et al., 2003). In this study, attitudes toward technology-based self-directed learning represent undergraduates' overall affective responses to utilizing technology in English language learning. In the TAM (Davis et al., 1989), individuals' attitude toward using technology (Teo, 2010, 2012; Jan and Contreras, 2011) was significantly predicted by perceived usefulness and ease of use of technology, which was in turn hypothesized to affect their behavioral intention to use technology and actual use.

Previous studies support the notion that students' perception of technology environments constitutes an important element for their academic-related beliefs. Specifically, students perceiving the convenience and availability in their interactive learning process report higher motivation, engagement, and persistence in learning (Wentzel et al., 2010; Tas, 2016). Some empirical evidence also indicated that students' perception of the technology environments is linked to attitude toward technology-based self-directed learning. However, the previous studies on technology use and its influencing factors mainly build on cross-sectional study. Importantly, in the current literatures, longitudinal studies are insufficient; thus, little is recognized about how earlier technology acceptance and technological self-efficacy in the learning process are associated with students' attitude toward technology-based self-directed learning later. Thus, the relation between students' perceptions of technology environments and later attitude toward technology-based self-directed learning deserves further investigation.

To extend the literature, the fundamental aim of our study was to inquire into the relation between students' acceptance of technology environments, technological self-efficacy, and their attitude toward technology-based self-directed learning. Based on previous literature (Kop and Fournier, 2011; Lai et al., 2012), this study hypothesized that students who perceive greater technology use would report higher levels of attitude.

Learning Motivation as a Mediator Between the Technology Acceptance and Technological Self-Efficacy and Attitude Toward Technology-Based Self-Directed Learning

Learning motivation is the sum of the incentives that positively force the choice of a specific behavior or purpose (Jarvis, 2005). As a major psychological concept, motivation is widely believed to be an important factor contributing to students' acquisition outcomes of second or foreign language (Lamb and Arisandy, 2019). One leading psychological theory of motivation that was typically applied in language acquisition and cognition is the self-determination theory (SDT) put forward by Deci and Ryan (2000). SDT concentrates largely on how environments support or thwart people's basic psychological needs for autonomy, competence, and relatedness (Jeno et al., 2019). "From a SDT perspective, individual motivation is defined as the degree of autonomy that individuals display during learning activity, and it falls into two major motivational orientations: (1) self-determined forms of intrinsic motivation; and (2) controlled forms of extrinsic motivation (Gan, 2020, p. 3)." Therefore, SDT constructed a theoretical foundation for the motivation process about individual self-determination behavior, stipulating that the environment enhances the internal motivation and promotes the internalization of the external motivation by satisfying the basic psychological needs of the individual. Therefrom, the study of learning motivation was shifted from the understanding of the internalization process of learning motivation to creating an environment conducive to self-determination, initiating a new perspective on the follow-up study of learning motivation. According to Deci and Ryan (2000), intrinsic motivation helps to construct students' experience of pleasure, enjoyment, and satisfaction, which in turn would further motivate their learning engagement (Dysvik and Kuvaas, 2013). In the present study, SDT has shaped our view of learning motivation. Intrinsically motivated students in technology-based self-directed learning not only seek external technology-enhanced resources but also develop idiosyncratic cognitive intention (Stafford et al., 2004). Extrinsic motivation mainly focuses on the desired consequences that learners behave to achieve (Dysvik and Kuvaas, 2013). Significantly, related studies have conformed to the positive and strong associations between intrinsic motivation and extrinsic motivation (Gonzales, 2011). Technology-based self-directed learning, as an activity and event for learners to undertake their own learning responsibilities (Perry and Winne, 2006), not only entails the accessibility of technology but more importantly the acceleration of learning motivation. "This is because students today are becoming more complex, requiring the researcher to look beyond technology-related enablers (e.g., motivation, social; Hashim et al., 2015, p.383)." Mercer (2011) considered self-directed language learning behavior to be contingent on "a learner's sense of agency involving their belief systems, and the control parameters of motivation, affect, metacognitive/self-regulatory skills, as well as actual abilities and the affordances, actual and perceived in specific settings" (p. 9). As motivation is acknowledged as the internal force and decisive factor to induce, promote, and maintain individual learning activities, a number of researchers have conceptualized the theories of learning motivation and explored the contribution of learning motivation to students' readiness, willingness, and intention to use technology for learning. Chiu et al. (2007) analyzed the antecedents of web-based learning continuance, finding that students' technology-based learning intention was mediated through their satisfaction with technology use for learning. Knowles and Kerkman (2007) identified the linkage between learning motivation and attitude when students are engaged in online learning. Based on TAM and motivational and social-cognitive frameworks, Ifinedo (2017) identified that students' intrinsic motivation and attitudes toward blog use significantly determined students' intention to continuously utilize blogs for learning. Additionally, Romero-Frías et al. (2020) explored how motivation influences students' participation in MOOCS and how they are associated with technology acceptance variables. Under the background of diverse learning resources and channels, the external technological conditions could better accommodate students' emerging learning needs. Technological learning motivation is characterized with learners' perception of their capabilities to use technology to execute courses of actions to achieve intended outcome (Compeau and Higgins, 1995), is argued to have a significant positive influence on technology acceptance and use (Straub, 2009), and has been used as a proxy of individuals' control beliefs in technology use (Venkatesh and Davis, 1996).

Technological learning motivation highlights that students' attitude toward technology-based self-directed learning is related to satisfying their basic psychological needs of competence and regulate their behavior in the achievement-related context. Despite the evidence on the importance of students' perceptions of technology climate on their attitude toward technology-based self-directed learning, less is known about the mechanisms through which the technology acceptance and technological self-efficacy affect the students' attitude toward technology-based self-directed learning. Thus, to extend the literature, this study tested whether learning motivation mediated the links of students' perception of technology acceptance and technological self-efficacy with their attitude toward technology-based self-directed learning.

Few studies explored whether learning motivation may explain the associations between the technology acceptance and technological self-efficacy and students' attitude toward technology-based self-directed learning, and none of previous studies assessed the simultaneous role of technology acceptance

and technological self-efficacy. Grounded on the previous literature, this study anticipates that learning motivation would be positively correlated to technology use and learning attitude. Further, it is expected that the perception of technology climate would predict students' perception of learning motivation, which in turn would predict their attitude toward technology-based self-directed learning. Few previous studies exploring the relation between technology climate and students' perceived attitude toward technology-based self-directed learning have been conducted in samples of students from Asian countries, especially China (e.g., Teo, 2009; Lai et al., 2012). To enhance the literature in the Asian countries, including China, which are characterized by different social and political ideology (Schwartz, 2006), a sample of Chinese undergraduate students was recruited to participate in the study, aiming to explore the specific relations between the perception of technology acceptance and technological self-efficacy and students' learning motivation and attitude toward technology-based self-directed learning in Eastern Asian cultural contexts.

Research Questions

Informed by the above discussed new visions in technology use for educational research, the overarching research questions for the present study are as follows:

1. What are the contributions of technology acceptance and technological self-efficacy to attitude toward technology-based self-directed learning?
2. Will learning motivation mediate these relationships?

METHODOLOGY

Participants

A total of 332 freshmen students (118 boys, accounting for 35.5%) studying for a college English course in the university where the author works in Eastern China participated in the study. Noticeably, in China, college English involves the exclusive use of the English as a second language as the medium for instruction and learning and is a compulsory course for undergraduate students for a minimum of 2 years. Nowadays, as network technology advances, college English teaching and learning initiate full utilization of technology, especially for language learning beyond class.

Procedure

This study comprised three steps. For step 1, at the beginning of the semester in September, 332 freshmen students from six classes of college English course were instructed and introduced into utilizing available technologies to conduct self-directed language learning beyond class. For step 2, at the end of the semester in January, the participants filled in the hard-copy questionnaire regarding technology acceptance, technological self-efficacy, and attitude toward technology-based self-directed learning for an anonymous survey. At intervals before class, the questionnaire was distributed to all the 332 freshmen in the classroom, answered on the spot, and recycled immediately. Students' participation was cooperative and voluntary, and thus they carefully completed the questionnaire. All the collected 332 questionnaires were valid, with a 100% completed rate. All the research data collected were anonymized to protect participants' privacy. For step 3, at the end of the second semester in July, the 325 students completed the hard-copy questionnaire regarding learning motivation as they did in the second step; the 7 absent students completed this questionnaire through the second round of supplementary procedures, and thus, in total, 332 valid samples were collected.

Measures

Technology Acceptance and Technological Self-Efficacy

The survey questionnaire that was validated from previous studies in educational settings (e.g., Davis, 1989; Teo, 2009) was used to assess students' perceptions of technology acceptance and technological self-efficacy. Technology acceptance was measured using two scales: perceived usefulness (seven items, e.g., technology use helps expand learning opportunities) and perceived ease of use (four items, e.g., the use of technology does not require many instructions). Technological self-efficacy was assessed using five items, e.g., I know how to use technology on my own. A six-point Likert scale was used for the questionnaire items, ranging from 1 (strongly disagree) to 6 (strongly agree). Higher scores indicated higher perceptions of technology acceptance and technological self-efficacy. The standardized factor loadings (SFLs) of the 16 items of technology acceptance and technology self-efficacy range from 0.804 to 0.940, and the Cronbach α values of technology acceptance and technological self-efficacy are 0.898 and 0.879, respectively. In addition, the Kaiser-Meyer-Olkin (KMO) value for validity is 0.918 and 0.907, respectively, indicating that the questionnaire has a good reliability and validity. Finally, the confirmatory factor analysis (CFA) was conducted to determine the validity of Technology Acceptance and Technological Self-Efficacy as an entire scale. Satisfactory model fits were found with $\chi^2/df = 2.459$, Tucker-Lewis index (TLI) = 0.952, comparative fit index (CFI) = 0.962, root mean square error of approximation (RMSEA) = 0.067, and standardized root mean residual (SRMR) = 0.049.

Attitude Toward Technology-Based Self-Directed Learning

The questionnaire of attitude toward technology-based self-directed learning was adapted from Compeau and Higgins (1995) and Saadé and Galloway (2005). The questionnaire contained eight items. A sample item is "I am keen on using technologies to facilitate self-directed language learning." Participants rated the degree of conformity with their attitude toward technology-based self-directed learning using a six-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The SFLs of the eight items range from 0.828 to 0.848, the Cronbach α values are 0.897, and the KMO value for validity is 0.912, indicating that the questionnaire has a good reliability and validity.

TABLE 1 | Descriptive statistics of study variables.

	n	Minimum	Maximum	Mean	SD
TA	332	1.60	6.00	5.26	0.74
TSE	332	1.67	6.00	4.63	0.98
LM	332	3.00	6.00	4.85	0.85
ATSL	332	2.60	6.00	5.06	0.76

TA, technology acceptance; TSE, technological self-efficacy; LM, learning motivation; ATSL, attitude toward technology-based self-directed learning.

TABLE 2 | Correlations among study variables.

S. No	Variables	1	2	3	4
1.	TA	(0.898)			
2.	TSE	0.306**	(0.879)		
3.	LM	0.516**	0.496**	(0.913)	
4.	ATSL	0.593**	0.427**	0.703**	(0.897)

*N = 332. TA, technology acceptance; TSE, technological self-efficacy; LM, learning motivation; ATSL, attitude toward technology-based self-directed learning. Reliabilities (Cronbach α) are shown on the diagonal in parentheses. **$p < 0.01$.*

Learning Motivation

In this study, the motivation factors described in Guilloteaux and Dörnyei (2008) and Kormos and Csizer (2014) were used, some of which were revised and developed in combination with the actual situation. A six-point Likert scale was used, and the participants were required to select according to the actual degree of compliance, from 1 "very inconsistent" to 6 "very consistent." Initial CFA revealed that factor loadings of two items ("I was ready to work hard at English through technology use" and "I really enjoyed learning English through technology platforms") were low. After the two items with weak factor loadings were removed, the CFA of the remaining 16 items got satisfactory model fitting: $\chi^2/df = 1.793$, TLI = 0.953, CFI = 0.952, RMSEA = 0.057, and SRMR = 0.062. The scale items included the following: (1) confidence and effort (seven items), (2) English language learning interest (four items), and (3) motivation to achieve learning goals (five items). The overall Cronbach α is 0.913, indicating a good reliability.

Method of Data Analysis

In this study, structural equation modeling was used, and a two-stage approach to data analysis was adopted (Anderson and Gerbing, 1988). The first step is to analyze the measurement model, which defines the relationship between the latent structure and the observed measurement factors. The second step is to analyze the structural model, which specifically defines the relationship among latent structures. Amos 21.0 was used to analyze the model, and a variance-covariance matrix as input and maximum likelihood as the method for estimation was adopted.

Several fitting indices were used to evaluate the overall model fit. Because the χ^2 test was highly sensitive to the sample size, the ratio of χ^2 to its degree of freedom (χ^2/df) was calculated. For a model to be assessed as a good fit, the χ^2 normalized by degrees of freedom (χ^2/df) should not exceed 3.00 (Carmines and McIver, 1981). In addition, TLI, CFI, RMSEA, and SRMR were used. Hu and Bentler (1999) suggested that TLI and CFI should be greater than or equal to 0.90 to indicate good suitability, and RMSEA and SRMR should be less than 0.06 and 0.08, respectively.

In addition, the significance of the mediation effects was assessed using the bias-corrected percentile bootstrap method (Hayes, 2013), computing the confidence interval (CI) for the mediated effect. When zero is not in the CI, it indicates the significance of the indirect effect; thus, the effects of the technology acceptance and technological self-efficacy on the attitude toward technology-based self-directed learning are mediated by learning motivation.

RESULTS

Demographic Information

In the demographic descriptions in the questionnaire, the mean age of the participants was 18.48 (SD = 0.55) years, and the duration of technology-based self-directed learning was specifically reported into learning when interested (76 students, accounting for 22.9%), less than 2 h per week (105 students, accounting for 31.6%), 3 to 6 h per week (90 students, accounting for 27.1%), and more than 7 h per week (61 students, accounting for 18.4%), and the used technology platforms (multiple choice) were reported to be as follows: mobile phone (280 students, accounting for 84.3%), our school's network resources (105 students, accounting for 31.6%), MOOC courses in Chinese universities (102 students, accounting for 30.7%), and other website platform resources (203 students, accounting for 61.1%).

Descriptive Statistics and Correlations

Table 1 presents descriptive statistics of the main study variables. The participants' gender did not significantly correlate with attitude toward technology-based self-directed learning, $r = 0.08$; $p > 0.05$.

All the measures had acceptable reliabilities (ranged from 0.879 to 0.913). Pearson correlation matrices for the relations between variables are displayed in **Table 2**, indicating that there are significant correlations among the study variables. But none of the correlation coefficients exceeded 0.80, excluding the issue of multicolinearity (Tabachnick and Fidell, 2007).

Test of the Measurement Model

The quality of the measurement model was tested *via* CFA. Convergent and discriminant validities were established by examining *t* value (CR > 2), the significance of individual item loadings, SE value (>0) of parameter estimation, and average variance extracted (AVE > 0.50). According to Teo and van Schaik (2012), convergent validity, which examines whether individual indicators are indeed measuring the constructs they are purported to measure, was assessed using standardized indicator factor loadings, and they should be significant and exceed 0.7, and AVE by each construct should exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). The results of

the data analysis in this study indicated that the SFL of all items of the constructs exceeded the minimum value of 0.70, and the AVE values ranged from 0.710 to 0.835, far higher than the threshold value of 0.50. Hence, this measurement model in this study established the convergent validity of all the measurement items. In addition, the test result of discriminant validity, which assesses whether individual indicators can adequately distinguish between different constructs, displayed that the square root of AVE of each construct was much higher (0.846–0.913) than corresponding correlation matrix (0.306–0.703) for that variable in all cases, thereby ensuring discriminant validity (Teo and van Schaik, 2012). Finally, there was adequate model fit for the measurement model, $\chi^2/df = 2.665$, TLI = 0.953, CFI = 0.967, RMSEA = 0.071, and SRMR = 0.047, indicating that the items were reliable indicators of the hypothesized constructs, thus allowing tests of the structural relationships in the various models to proceed (Teo and van Schaik, 2012).

Path Analysis Testing the Hypothesized Model

This study adopted Amos 21.0 to test the hypothesized model of Chinese undergraduate students' attitude toward technology-based self-directed learning in order to verify the influence of various factors and modify the hypothesis model according to preliminary test results. Compared with the modified hypothesis model, the unrevised hypothesis model contained the path of technological self-efficacy → attitude toward technology-based self-directed learning. The verification results showed that the standardized path coefficient is 0.065, SE = 0.032, CR = 1.812 (<2), $p = 0.155$ (>0.05), indicating that technological self-efficacy has no significant impact on attitude toward technology-based self-directed learning, so this study deleted this path and tested the modified model again.

The modified structural equation model (**Figure 1**) has a better fit. **Table 3** demonstrated that the standardized path coefficient is not close to or greater than 1, and the parameter estimation SE value is greater than 0, indicating that the parameters of the structural model are reasonable; the CR critical value is greater than 2, and the p value is significant at the level of 0.001, indicating that the parameters of the structural model are significant.

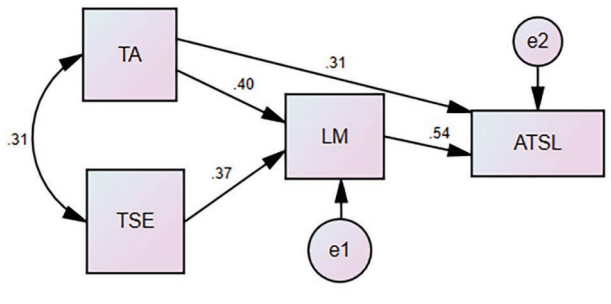

FIGURE 1 | Path analysis of the hypothesized model (n = 332). Standardized path coefficients are reported.

As shown in **Table 4**, the CMIN/DF value of the modified model is 2.986 (<3), indicating that the fitting value is better, and all the parameters (SRMR = 0.038 < 0.05, RMSEA = 0.075 < 0.08, CFI = 0.994 > 0.90, TLI = 0.962 > 0.90) meet the requirements of the fitting standard value. Therefore, this study considered that the modified model has a good fit.

Technology acceptance significantly predicted attitude toward technology-based self-directed learning (β = 0.313, $p < 0.001$) and learning motivation (β = 0.402, $p < 0.001$); technological self-efficacy significantly predicted learning motivation (β = 0.373, $p < 0.001$), and learning motivation significantly predicted attitude toward technology-based self-directed learning (β = 0.542, $p < 0.001$).

Assessment of Mediating Paths

The results indicated that learning motivation mediated the relation of technology acceptance with attitude toward technology-based self-directed learning: estimate = 0.462, SE = 0.052, 95% CI (0.177–0.292), indirect effect = 0.224; and the relation of technological self-efficacy with attitude toward technology-based self-directed learning: estimate = 0.323; SE = 0.039; 95% CI (0.106–0.212), indirect effect = 0.157, respectively.

DISCUSSION

In this study, there were more female respondents (64.5%). The analysis of variance conducted to examine the mean differences between male and female in their decision to utilize technology for self-directed learning showed no significant gender differences, which is consistent with the previous study from Perse and Courtright (1993). This indicated that gender does not influence students' decision to adopt technology for self-directed learning as they are equally motivated.

The demographic descriptions in the questionnaire demonstrated that Chinese undergraduate students had experience in adopting technology for self-directed learning purposes and had preferences to diverse technology platforms. From the findings, undergraduate students are more likely to adopt the technological medium that is able to tally with their technology acceptance and technological self-efficacy (e.g., mobile phone). This accords with the previous study from Mondi et al. (2008), who suggested that technology used to support learning should not be too complicated and able to allow them to have positive personal fulfillment toward knowledge construction during the learning process. Besides, the less utilization of both school's network resources (31.6%) and MOOC courses in Chinese universities (30.7%) demonstrated by this questionnaire survey highlighted the issue of educational compatibility, as previous studies have established compatibility as an important predictor of information system acceptance (Hardgrave et al., 2003; Liao and Lu, 2008).

This study explored the contribution of two individual characteristics—technology acceptance and technological self-efficacy—to attitude toward technology-based self-directed learning. This study also expanded previous research by assessing

TABLE 3 | Testing results of the modified hypothesis model.

Path	Path coefficient	SE	CR	*p*
TA → LM	0.402	0.052	8.895	***
TSE → LM	0.373	0.039	8.256	***
LM → ATSL	0.542	0.038	12.784	***
TA → ATSL	0.313	0.044	7.391	***

*Path coefficient = standardized path coefficient. ***$p < 0.001$. TA, technology acceptance; TSE, technological self-efficacy; LM, learning motivation; ATSL, attitude toward technology-based self-directed learning.*

TABLE 4 | Comparison of fitting test value and fitting standard value of the modified hypothesis model.

	CMIN/DF	SRMR	RMSEA	CFI	TLI
Fitting standard value	<3 is better, <5 is acceptable	<0.06	<0.08	>0.90	>0.90
Fitting test value of the modified hypothesis model	2.986	0.038	0.075	0.994	0.962

CMIN/DF = Chi-square/Degrees of freedom.

whether students' learning motivation mediated the relation between students' perceptions of technology use and their attitude toward technology-based self-directed learning. Specifically, it tested whether the technology acceptance and technological self-efficacy predicted students' perception of learning motivation, which in turn is associated with attitude toward technology-based self-directed learning.

Correlational analyses corroborated the links between technology acceptance and technological self-efficacy and attitude toward technology-based self-directed learning, which is consistent with previous studies (Teo, 2011; Lai, 2013). Specifically, students perceiving usefulness and easy use of technology in after-class self-directed learning also report higher attitude toward technology use. Additionally, the results of the path analysis by assessing the simultaneous influence of technology acceptance and technological self-efficacy together with the effects of other variables (e.g., learning motivation) involved demonstrated that technology acceptance and technological self-efficacy have a unique contribution to students' attitude toward technology-based self-directed learning. These results complement those previous studies that typically assessed related variables on the basis of TAM (e.g., Teo, 2009). Further, this study added to the current literature by adopting Chinese adolescent sample, indicating that, for Chinese undergraduate students, the perceptions of technology acceptance and technological self-efficacy impact on later attitude toward technology-based self-directed learning.

Although previous studies highlighted the links of related variables of students' technology acceptance (Teo, 2009; Lai, 2013), the other generating constructs (e.g., learning motivation) that may affect these associations have not been revealed. This study attempted to explore the latent effect that learning motivation may exert on explaining these associations. Initially, it examined how technology acceptance and technological self-efficacy were related to students' learning motivation. Results indicated that students who perceived greater technology acceptance and self-efficacy reported increased perception of learning motivation. These findings confirmed that external technology environment is a critical element for triggering students' learning motivation (Chen, 2020). These results also suggested that perceived support from technology use is particularly relevant for students' learning motivation and their attitude toward technology-based self-directed learning probably because they are confronted with the increasing technological modernity of the educational landscape (Lai et al., 2016).

Next, this study evaluated whether learning motivation is related to attitude toward technology-based self-directed learning. The results confirmed the links between learning motivation and attitude toward technology-based self-directed learning. Specifically, correlational coefficient ($\gamma = 0.703$, $p < 0.01$) and path analyses ($\beta = 0.54$, $p < 0.01$) showed that students with higher learning motivation also reported higher levels of attitude toward technology-based self-directed learning, indicating that learning motivation could be considered as an important antecedent for attitude toward technology-based self-directed learning (Elliot, 2006; Schunk and Pajares, 2009; Elliot and Hulleman, 2017). Importantly, our test of the relationships of constructs relies on the longitudinal data collected for a period of time after participants were instructed into technology use for language learning beyond class, which complements the literature of previous cross-sectional studies conducted in non-Eastern Asian samples.

Additionally, the study revealed that students' learning motivation explained the associations between students' perceptions of technology environments and their attitude toward technology-based self-directed learning. Specifically, learning motivation mediated the relations of technology acceptance, technological self-efficacy, and students' attitude toward technology-based self-directed learning. Concretely, students perceiving greater technology use later reported higher levels of learning motivation, and in turn, students with higher levels of learning motivation also reported greater attitude toward technology-based self-directed learning. This finding added to evidence to the research from Fırat et al. (2018, p. 63), which emphasized motivation as one "of the most important factors affecting the speed, intensity, direction, and persistence of human behavior." Overall, these findings confirmed that supportive technology environments exert positive influence on learning motivation, which in turn is an antecedent of learning attitude (Schunk and Pajares, 2009; Elliot and Hulleman, 2017). More importantly, this study provided the evidence concerning the explanatory mechanism of learning motivation for the relation between students' simultaneous perceptions of technology acceptance and technological self-efficacy and their attitude toward technology-based self-directed learning.

This study adopted a longitudinal approach to explore the relation between technology environments and attitude toward technology-based self-directed learning and identifying specific paths from the technology acceptance and technological self-efficacy to attitude toward technology-based self-directed learning. The results of this study must be interpreted with some caution

as several limitations exist. First, this study measured students' perceived technology environments, learning attitude, and learning motivation through self-reported data, which may have affected the accuracy of the results. Future studies could combine other research methods (e.g., online learning observation, interviews) to verify the study results. Second, the latent influence of the behavior conducted by teachers and peers was neglected in this study. Future studies should empirically test models including other teachers' or peers' behaviors, such as teachers' online feedback and peers' interactivity and mutual evaluations, to assess their relevance to students' attitude toward technology-based self-directed learning. Third, this study investigated the explanatory mechanism of learning motivation; however, other motivational factors, such as learning confidence, interest, or effort, might be taken into account for the relations between the technology acceptance and technological self-efficacy and attitude toward technology-based self-directed learning so as to deepen the understanding of the relations between the characteristics of technology environments and students' attitude toward technology-based self-directed learning. Finally, learning motivation in this study was investigated as a general concept that influenced students' adoption of technology for self-directed learning. It is suggested that the future research in this area would focus more detail on individual concept of learning motivation, analyze its dimensions more thoroughly (not as a single concept, but as a composite of many underlying concepts), and study them in a more concrete context (e.g., a specific type of learning, technology, etc.).

CONCLUSION

At present, the development and application of technology have brought about innovations in the learning style of undergraduate students. In this educational landscape, this study explored the contribution of technology acceptance and technological self-efficacy to attitude toward technology-based self-directed learning in a sample of Chinese undergraduate students and also investigated whether learning motivation mediated these associations. The analysis of fitting results shows that in the process of technology environments contributing to attitude toward self-directed learning behavior, learning motivation significantly mediated this relationship. This result not only confirmed the theoretical hypothesis that technology environments contribute to the attitude toward self-directed learning behavior through learning motivation, but also revealed the internal mechanism of motivation contributing to the attitude of self-directed learning. On the one hand, learning motivation can promote learners' attitude of self-directed learning. On the other hand, learning motivation can have a significant impact on the achievement of self-directed learning. Rotgans and Schmidt (2012) argued that learning motivation is indispensable as it directly affects learners' perception of learning effectiveness and even strengthens learning behavior, thus playing a self-reinforcing role in the process of self-directed learning. The conclusions suggest optimizing the curriculum design, improving the role of technology in students' learning, especially making more effective use of technology for self-directed language learning beyond class, and meanwhile stimulating students' learning motivation.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article are available on request to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR'S NOTE

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AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Schadenfreude: Malicious Joy in Social Media Interactions

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The paper presents a model of Schadenfreude, pleasure at another's misfortune, resulting in a typology of cases of this emotion. Four types are singled out: Compensation, Identification, Aversion, and Injustice Schadenfreude. The typology is first tested on a corpus of 472 comments drawn from three social media, Facebook, Twitter and Instagram. Then a specific corpus of comments is collected and analyzed concerning a specific case of Injustice Schadenfreude, the posts concerning Brexit, United Kingdom leaving the European Union. From the analysis, it emerges that spatial or factual closeness does not look necessary to feel Schadenfreude. Finally, a lexicometric automatic analysis is conducted on the general corpus of Italian comments collected using several hashtags and enriched by comments about the fire of Notre Dame, showing how even complex emotions like Schadenfreude can be automatically extracted from social media.

Keywords: schadenfreude, emotion classification, lexicometric analysis, social media, adaptive functions of emotions, emotion extraction

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INTRODUCTION

The social media have projected us into an age in which people are encouraged to express whatever they know, think, and feel. This means that not only information and opinions, but also emotions are spread all over the world net. Thus the social media become an inexhaustible mine of data to obtain information also on emotions that, despite their being quite frequent in everyday life, and often clearly displayed in the media, are not so investigated as primary emotions or other types of them. This work focuses on the emotion of Schadenfreude, and exploits the richness of the social media as a repository of cases in which people experience and express this feeling (Ellison et al., 2007; Pang and Lee, 2008; Go et al., 2009; Burke et al., 2010; Bollen et al., 2011; Ceron et al., 2014; Marmo, 2016; Pozzi et al., 2016).

Schadenfreude is a German term composed of *Schaden*, that means "harm," and *Freude*, that means "joy," so the word *Schadenfreude* refers to the pleasure at another's misfortune. Though no clear-cut translation perfectly renders the German meaning, a close phrasing in English can be "malicious joy." Notwithstanding the subtleties of its naming and definition, Schadenfreude is quite a frequent emotion nowadays, being linked to very important aspects of our life, such as justice and social image. The objective of this study is to propose a model and a typology of cases of Schadenfreude so as to highlight its different facets allowing more precise studies on its sub-types. To test the adequacy of the proposed model and the diffusion of this emotion, we exploit social media as a repository of cases of Schadenfreude, investigating how it is expressed on these platforms.

RELATED WORKS

Although the literature on Schadenfreude is not very rich, some studies have provided definitions and typologies of it, also investigating its expression and its neurophysiological mechanisms.

van Dijk and Ouwerkerk (2014) defines Schadenfreude as follows: "*we do restrict the term "schadenfreude" to the pleasure at misfortunes of others that are not directly caused by the schadenfroh person (otherwise we would consider this more akin to sadism) and are not the result of actively defeating others through direct competition (otherwise we would consider this more akin to victorious joy or gloating).*" This definition stresses how Schadenfreude can be considered a kind of joy but an atypical kind of it. Literature on emotions highlights several differences between pure joy and Schadenfreude. An electromyographic analysis by Boecker et al. (2015), looking for differences in facial muscles activation between pure joy and Schadenfreude, in both detected an activation of the same muscles: an increase of Musculus zygomaticus major and M. orbicularis oculi activity, decrease of M. corrugator supercilii activity, no activity change of M. frontalis medialis; yet, electromyography indicated stronger reactions in the Schadenfreude condition, although participants claimed they had felt a greater pleasure in the case of joy.

These results might be accounted for by the fact that Schadenfreude, just as other emotions like envy (Benincà, 1992; Krasnova et al., 2013; Giardini, 2015; Lim and Yang, 2015), is not socially approved (Powell and Smith, 2013), and since its expression is sanctioned it may be deliberately inhibited. Indeed, malicious joy can be considered a moral failure, but it can also be permissible unless it is a part of a causal chain that conducts to an immoral act. Actually, Spurgin (2015) compares Schadenfreude's moral status to one of a sexual fetish, which is not immoral in itself, but sharing and talking about it may be so in some contexts. This social sanction might account for the finding of Ruch et al. (2013) that Schadenfreude often displays Action Unit AU4, the frowning eyebrows movement more typical of negative emotions: Schadenfreude's entailing, beside the facial expression of enjoyment, also a sign of negative emotion (AU4) might stem either from the need to conceal sanctioned pleasure or from the blending of positive and negative feelings.

Concerning the expression of this emotion, Authors of the 19th and 20th century (e.g., Darwin, 1872; Ekman and Friesen, 1982; Ruch and Ekman, 2001) attempted to classify different kinds of laughter, but the facial features associated with Schadenfreude have been examined only recently. Ruch et al. (2013) analyzed four types of laughter (joyful and intense laughter, Schadenfreude and grinning) in terms of Ekman's Action Units and collected their recognition rates in an experimental study: while joy and intense laughter are quite easily discriminated, respectively, by the Duchenne Display and mouth opening, Schadenfreude and grinning are not easy to distinguish. In search for the expressions of Ekman's (2003) enjoyable emotions—among which relief, amusement, gratitude, and Schadenfreude—Hofmann et al. (2017) found that, when an individual feels unobserved, the laughter associated with Schadenfreude is as intense as joyful laughter; furthermore, all 16 enjoyable emotions elicit smiles and laughs, but most smiles and laughs occur in amusement, excitement and Schadenfreude.

In a neurophysiology study, Takahashi et al. (2009) found that oxytocin (the so-called "hormone of love") is involved in the amplification of experienced Schadenfreude. Nineteen participants, 10 men, and 9 women were asked to identify themselves with the protagonist of a scenario. Then they were presented with misfortunes suffered by other individuals in the scenario while their brain activity was monitored by fMRI. The study showed that higher envy corresponds to higher Schadenfreude, since activations of the striatum were also detected in case the misfortune had struck a subject toward whom one felt envious, while otherwise they were absent. It also emerged that Schadenfreude causes a feeling of pleasure when bad luck strikes a lucky or advantaged person and helps to lower the difference between the subject and the victim of misfortune.

Schadenfreude can be found in different settings of everyday life: during sport, in political confrontation but also in the daily interactions with friends, family or colleagues. To investigate the onset of Schadenfreude in different contexts, Ouwerkerk et al. (2015) in a study examined the reactions of supporters of an opposing party at the time of the fall of the government, in another the reactions of buyers of blackberry brand phones when they received negative news on a rival brand, for example Apple. This work shows that belonging to a particular ingroup causes an increase of Schadenfreude when receiving news of misfortunes or negative events that affect an outgroup.

The diverse examples of Schadenfreude mentioned in the literature, along with most studies' failure at finding a single unmistakable facial expression of it, might be due to the fact that several types of Schadenfreude exist—even, possibly distinguished by different facial/bodily displays.

Actually, different displays might reveal different types of the same emotion, as it has been found concerning the four subtypes of pride (Poggi and D'Errico, 2012). While no attempt has been made so far at finding out clear-cut differences in the expressions of Schadenfreude, on the feeling side of it different categorizations of Schadenfreude have been proposed. One is the typology by Cecconi (2017), drawn bottom-up from data collected in an interview to six subjects (three males and three females) and a survey study. In the survey, 100 subjects (67% women, 33% men) were asked, in a questionnaire of 13 open and close-ended questions, to tell cases in which they had felt Schadenfreude. Four types emerged from this study: Aversion; Injustice; Identification; Compensation.

- *Aversion:* Subject A feels a sense of dislike of subject B. When subject B undergoes an unfortunate event, subject A experiences Schadenfreude (e.g., *I experienced Schadenfreude when a person I disliked failed an exam*).
- *Injustice:* Subject B commits an unfair act or receives an undeserved advantage. When an unfortunate event happens to B, subject A feels Schadenfreude (*I felt Schadenfreude when a person who betrayed a friend of mine was betrayed by his girlfriend*).
- *Identification:* Subject A is involved in direct rivalry/competition with subject B. When subject B

suffers a misfortune, subject A feels Schadenfreude (*I felt Schadenfreude when a rival team of the one I cheered for lost a game*).

- *Compensation:* Subject A suffered an unfortunate event. When subject B also suffers the same kind of unfortunate event, subject A feels Schadenfreude (*I felt Schadenfreude when my boss denied a day off to me. On the day I had asked for, the weather was bad, so no one enjoyed that day*).

Another typology, obtained top down from the study of pre-existing literature, was proposed by Wang et al. (2019) who distinguish three types of Schadenfreude:

- *Aggression: it derives from a previous sense of social identity formed during childhood, a sense of belonging to an ingroup.*
- *Rivalry: the Schadenfroh focuses on one's own social status comparing it with the status of those who have suffered the negative event.*
- *Justice: Justice Schadenfreude focuses on the other and not on its status, therefore it can be felt when social comparison is involved, and it is other-oriented.*

Therefore schadenfreude seems to be an instrument of power (Leach and Spears, 2008; Leach et al., 2015) capable of reducing the dominance of other members of the society as seen in Lange and Boecker (2019) *"Seven studies (total N = 2,362) support that (a) schadenfreude is a reaction to a misfortune befalling an initially dominance-displaying individual and (b) the public expression of schadenfreude downregulates the dominance of the other person. Specifically, schadenfreude toward initially successful persons was intensified when they displayed dominance (i.e., hubristic pride or general dominance) instead of prestige (i.e., authentic pride or general prestige) or other displays (i.e., embarrassment) following their achievement (Lange and Boecker, 2019, p. 1)."*

THE MENTAL INGREDIENTS OF EMOTIONS

Here we present a socio-cognitive model of emotions and of their biological and social functions, and then illustrate our definition and typology of Schadenfreude.

An emotion is a complex subjective state composed of cognitive aspects, feelings, physiological processes, expressive displays, and motivational aspects. In this work we focus on the cognitive and motivational aspects of Schadenfreude. These aspects are those we call the "mental ingredients" of emotions (Castelfranchi, 2000; Miceli and Castelfranchi, 2007; Poggi and D'Errico, 2012, 2018), the beliefs that are represented in the mind of an Agent when s/he is feeling a specific emotion: beliefs concerning the event triggering the emotion (e.g., I may feel guilty if I have the belief I hurt someone), attributions (guilt may imply I was the cause of the other's damage), evaluations of oneself or others (guilt entails a negative evaluation of myself). The motivational aspects are the goals that are triggered during the emotion—for instance, anger triggers fight, fear triggers flight, pity, helping behavior—and the biological goals of the Agent that are monitored by that specific emotion. In fact, since the function of the emotions is to monitor the state of achievement or thwarting of the adaptive goals of individuals (Frijda, 1986), each emotion reveals the underlying presence of its specific monitored goal.

According to Poggi (2008a), in everyday life we consciously pursue the specific goals of our activities (e.g., accomplishing the tasks of our job, studying books to perform well in the examination) and of our interaction with others (going to parties to find a boyfriend), but in any moment of our life, even though we are not usually conscious thereof, we are also regulated by a few goals that are essential to our adaptation, and any time one of these high level adaptive goals is achieved or thwarted we feel the emotion devoted to monitor that goal. For example, if I am reporting about my job task in a meeting, but suddenly see flames in the room, I feel fear and escape, because the goal of survival and safety is at stake; if while jogging to keep in shape I involuntary hurt an old woman and she falls down, I feel guilty because a goal to avoid undeserved damage to others is salient.

The goals that regulate us in all moments of our life on behalf of our individual and social adaptation include, for example: (1) the goals of survival and safety for us and people we love, that are monitored by emotions like fear or worry when threatened; (2) one of knowledge acquisition, monitored by the emotions of surprise, curiosity, amusement, boredom; (3) the goal of justice, that causes anger in the victim undergoing injustice and guilt in its perpetrator; (4) the goals of image and self-image, monitored by the positive emotion of pride and the negative one of shame; (5) the goal of others' image, of evaluating others to decide what kinds of interaction to have with them, monitored by admiration and contempt; (6) the goal of gaining or not losing power as against others, monitored by envy.

The first point of this paper is then to single out the mental ingredients of Schadenfreude, which, beside allowing us to distinguish different types of it, might give us a hint on which goals are monitored by Schadenfreude in general or by its specific types.

TYPES OF SCHADENFREUDE AND THEIR MENTAL INGREDIENTS

To single out the mental ingredients of an emotion one has to analyze several cases of it and gather their recurrent and differential elements. The cases of Schadenfreude reported by 100 subjects in a previous corpus (Cecconi, 2017) may be analyzed in terms of mental ingredients as follows.

1. *Two friends of mine at high school suddenly decided to leave me for no reason. Some years later I came to know that their friendship too had come to an end, despite their having been best friends for long time.*

   B1 and B2 do deliberate action K1 (leave A for no reason)
   K1 causes damage to A
   A does not deserve undergoing damage
   A has aversion toward B1 and B2

A has the goal for B1 and B2 to undergo damage
A expects B1 and B2 will not be punished for damaging A
Negative event K2 occurs to B1 and B2 (their friendship over)
K2 causes damage to B1 and B2
A feels K2 as a just punishment against B1's and B2's previous action
A feels happy

2. *I saw a young man parking in a place reserved for the disabled, but later the traffic guard imposed him a fine.*

B does deliberate action K1 (violates traffic laws)
K1 causes damage to a disabled
K1 causes damage to society in general qua norm violation
A has aversion toward B
A has the goal for B to undergo damage
A expects B will not be punished for damaging A
C sanctions B
C causes damage to B
A feels damage to B as a just punishment of B' previous action
A feels happy

In these two cases, Agent A feels Schadenfreude because Agent B (or Agents B1 and B2) caused A or other Agents an undeserved damage, but later some event occurs (friendship broken) or an action (fine imposed) is performed by another Agent C that causes some damage to B in its turn; and A feels this damage occurred to B as a just punishment for an incorrect previous action. In these cases, that we call "Injustice Schadenfreude," the emotion felt monitors the goal of justice, i.e., the goal that one does not receive undeserved damage from others; when damage had been made, a sense of injustice had been felt, but when some retaliation for the damage comes in the form of the other's deserved misfortune, this triggers the positive emotion of Schadenfreude.

3. *I failed an exam. Later I came to know that many friends of mine failed it too. I was very happy with that.*

A does involuntary action K1 (fails exam)
K1 causes damage to A's image
A wants to have a positive image
A expects one's image to be definitely inferior to B's
B does involuntary action K2 (fails exam)
K2 causes damage to B's image
K2 re-balances images of A and B
A re-evaluates his own image
A feels relieved about his image
A feels happy

In this example some damage is caused to A by an event (failing the exam, caused by his involuntary action), which causes him a loss of face, letting him feel inferior to others. But when someone else incurs in a parallel face loss, this allows A not to feel so inferior. We call this type "Compensation Schadenfreude," because the loss of face of others compensates A from his own face loss. The function of this emotion is to monitor the goal of image and self-image: being evaluated by others and by oneself positively. Given the importance of a positive image and self-image in order to our relationships with others, and in order to foster our skills, learning, and motivation to action, any time our image or self-image is lowered we feel negative emotions like shame or humiliation; but since both image and self-image are mainly based on social comparison, as we feel inadequate we implicitly compare ourselves to others, seeing them as a blatant demonstration that we are definitely inadequate, whereas, they are not. When we see that others are not that better than ourselves, we feel "Compensation Schadenfreude": a sort of relief from shame, due to our coming back to a sense of adequacy.

4. *I am a fan of Roma football team. I felt Schadenfreude when Lazio was defeated by Inter.*

A is a fan of team C (Roma)
C is an opponent of B (Lazio)
B wants to cause damage to C (B opponent of C)
B does action to cause damage to D (Inter)
A wants B to be damaged
A expects B not to be damaged
D (Inter) causes damage to B (Lazio)
A feels happy

Here A, being a fan of team C, is indirectly a rival of B, the team rival of C, and therefore is happy when B is defeated by another team D. We call this "Identification Schadenfreude" because A identifies himself with team C, so that any goal of C, even seeing a rival humiliated, becomes his own goal, and he enjoys for any fortune or achievement of C: here, the lucky case that B, the opponent team of C, is defeated by another team D. This type of Schadenfreude monitors the goal of cooperation: we are happy when something good happens to our ingroup, including damage suffered by the outgroup.

5. *A boy I could not stand since the grammar school some years ago told me his life was going failed, I felt pleasure in knowing it*

A has aversion toward B
A wants B to be damaged
A expects no negative event to occur to B
Negative Event K1 causes damage to B
A is happy

We call this "Aversion Schadenfreude": it is the simplest case of Schadenfreude, the least complex one as to its mental ingredients. Here it is not necessary for B to do injustice to A nor for A to feel ashamed, nor even for A to identify himself with his ingroup against an outgroup. A minimal condition for one to feel Schadenfreude is for A to feel ill-will, malevolence toward B. The conditions of B doing injustice or being an (indirect) rival of A ("Justice" and "Identification" Schadenfreude), may be sometimes added to this ingredient of AVERSION, which is the core of Schadenfreude and of the malevolence embedded in it. Since aversion by itself entails ill-will toward the other, this

determines A's goal for B to undergo some damage, which when fulfilled causes A's malicious joy. The function of this type of Schadenfreude is to monitor the goal of defense: sometimes we have (possibly intuitive, non-rational) negative impressions about other people, that we think might hurt us, and we need to defend ourselves from them. And aversion is a tendency to avoid positive social relationships with someone.

THE SHARED INGREDIENTS

This first analysis shows that some mental ingredients are shared by some cases of Schadenfreude. A necessary ingredient is some DAMAGE TO B, which can be caused by a deliberate action of a third Agent (a traffic guard in ex.2, the rival team in n.4), or of B oneself (ex.3), or simply by an event (ex.1, 5). In some cases some specific DAMAGE was caused to A (ex.1) or others (society, third Agents, ex.2) by an INADVERTENT ACTION of A himself (ex.3), or a DELIBERATE ACTION of B (ex.1, 2); but no direct damage is suffered in some cases by A (ex.4, 5). In some cases some AVERSION of A toward B is embedded: in ex.1, because B directly hurted A, in ex. 2, because B violated some moral or legal norm. But in ex.5, the bare ingredient of AVERSION is sufficient for A to feel Schadenfreude when knowing of B's misfortune.

Another ingredient of some types of Schadenfreude is the DISCONFIRMATION OF SOME EXPECTATION: the event which finally occurs is one that A wanted to occur, but that s/he believed very unlikely. Namely, A expects that the damage to oneself or others, or the relative luck of B, will not be rebalanced: in 1 and 2, A expects nothing will punish B (or B1 and B2) for their misdeed, and Schadenfreude comes when this expectation is disconfirmed; in 3, after failing the exam, A expects to be the only one inferior to his friends; in 4, A fears (has the negative expectation) that B will not be defeated, and in 5 A does not expect B's misfortune. In all cases, Schadenfreude appears as a kind of relief, the emotion we feel when some negative expectation is disconfirmed (Castelfranchi, 2005; Miceli and Castelfranchi, 2015); but it is a social relief: a sort of consolation from a pessimistic, disappointed idea of how things go in life. We do know that injustice, bad image, rivalry and aversion exist between us and other people, and although we strongly would like damage to ourselves or the society to be rebalanced or returned by damage to another, we sometimes resign that everything goes wrong; but when unexpectedly it happens that justice has been done, that we are not the worst of all, that our ingroup will be saved from rivals, or even that people we do not like are not always the winners, then we feel the particular relief of Schadenfreude.

On the other hand, our analysis might also account for the moral sanction to which the expression of Schadenfreude and its very feeling are subject, and to the function of the sanction itself. Schadenfreude is the opposite of empathy: while empathy implies taking part in the others' suffering and induces to help them, malicious joy is being happy with the others' misfortune. So the hard sanction that hits this emotion—and the very function of this sanction—might depend on the fact that enjoying the other's misfortune violates a general norm of altruism—a norm of caring the others' goal.

A MODEL TO CLASSIFY SCHADENFREUDE

This is, therefore, our definition of Schadenfreude: a positive emotion, a kind of relief that we feel when some damage occurs to others, due to either an external negative event or to their own or other people's action, which brings about a rebalance with respect to unjust actions performed by others, or undeserved actual or foreseen unbalance between us and them.

Such relief is due to the disconfirmation of our negative expectations that our goals of justice, image, cooperation or defense are systematically thwarted. Therefore, the function of Schadenfreude is to monitor these adaptive goals.

With this study we now propose a new model of Schadenfreude that distinguishes different types of this emotion, allowing us to distinguish them by answering a few simple questions, after setting apart Schadenfreude from other similar emotions such as gloating or sadism. **Figure 1** is a graphical representation of this model.

Schadenfreude Versus Other Emotions

The first step of our model is to distinguish Schadenfreude from similar emotions like gloating and sadism. Coherently with Van Dijk's specification, we distinguish malicious joy from gloating and sadism by answering two questions:

1. Did A actively participate in a competition in which he defeated B?
   We distinguish Schadenfreude from gloating because in the case of gloating subject A (the "gloating" subject) must have actively defeated subject B in some kind of direct competition.
2. Is A involved as the cause of the misfortune that hit B?
   We distinguish Schadenfreude from sadism because in sadism A (the "sadistic" subject) acts directly and actively to cause the misfortune of subject B.

If the answer to the first question is affirmative, the case under examination is not malicious joy but gloating, while if the answer is negative the case under consideration could be a case of Schadenfreude. Then the second question comes: if the answer to the second question is affirmative, the examined case is one of sadism, but if negative this is a case of Schadenfreude.

Categories of Schadenfreude

We identify three macro-categories of malicious joy based on the relationship between the Schadenfroh subject and the victim of misfortune:

1. Image Schadenfreude
   a. Compensation
   b. Identification
2. Aversion Schadenfreude
3. Injustice Schadenfreude

In Image Schadenfreude the Schadenfroh compares himself with the victim of misfortune and at the end of the comparison,

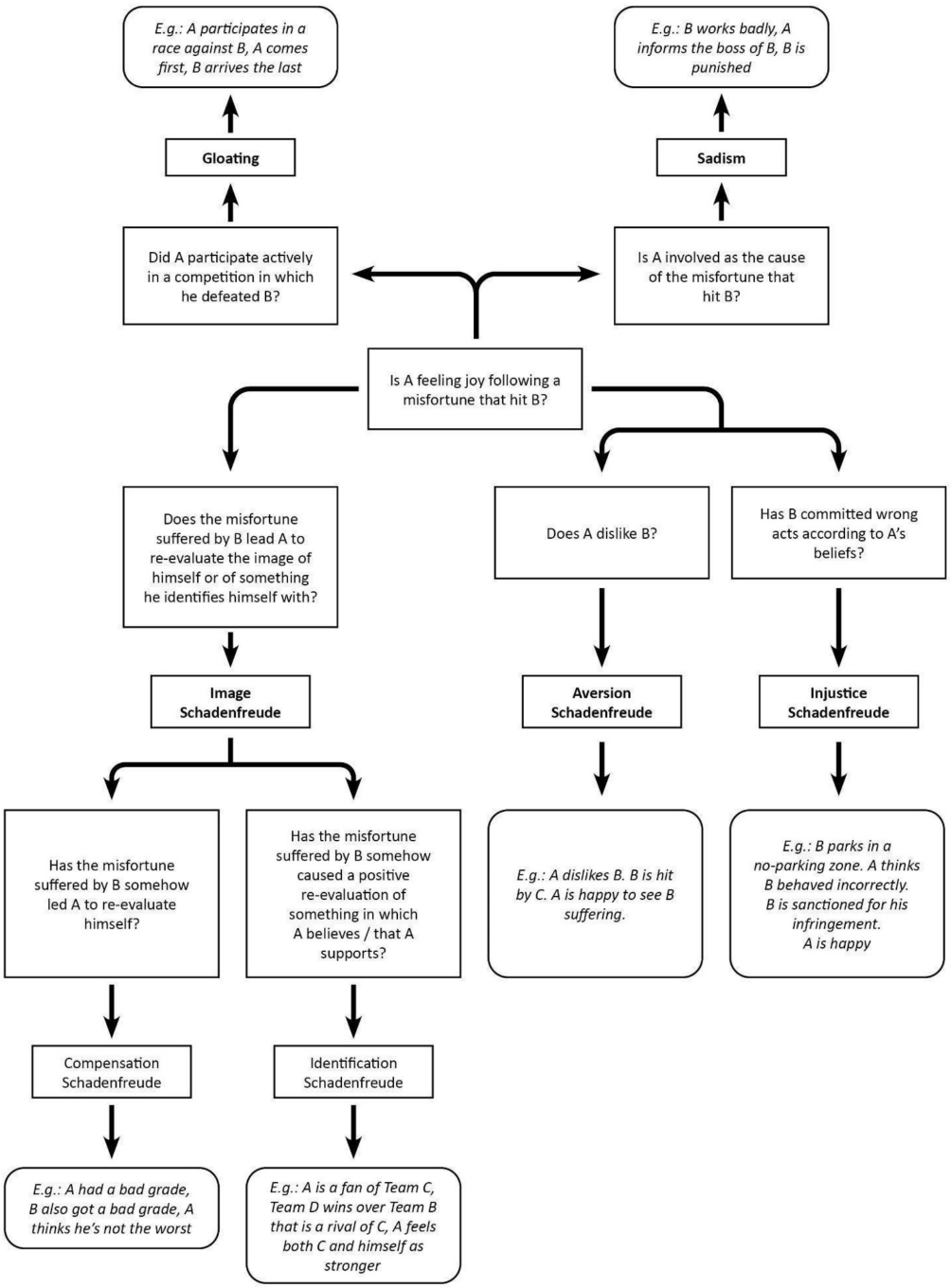

FIGURE 1 | Schadenfreude classification model.

due to the victim's failure, he positively re-evaluates either himself (Compensation Schadenfreude) or something he supports or believes in (Identification Schadenfreude). To verify if the case under consideration is a case of Image Schadenfreude we include the following question:

- *Does the misfortune suffered by B lead A to re-evaluate himself positively?*

In the case of Aversion Schadenfreude the Schadenfroh approaches the victim of bad luck with dislike, despising him. He evaluates negatively the victim of the bad luck simply due to the way he is or behaves, intensely rejoicing in his misfortune. To verify if the case under consideration is a case of Aversion Schadenfreude we include the following question:

- *Does A dislike B?*

Injustice Schadenfreude refers to cases in which the Schadenfroh knows of past incorrect behaviors of the victim of bad luck, and sees such bad luck as a "punishment" for those behaviors. To verify if the case under consideration is one of Injustice Schadenfreude we include the following question:

- *Has B committed incorrect acts according to A's beliefs?*

All in all, we have four types of Schadenfreude, since within Image Schadenfreude we distinguish two sub-types: Compensation and Identification.

- **Compensation:** Here a distinctive element is the fact that subject A somehow, witnessing the misfortune of subject B, succeeds in re-evaluating himself directly
- **Identification:** In this case, generally the victim of the misfortune is an entity B that is in some way in competition with an entity C which subject A supports or in which A identifies himself.

In both cases, the function of malicious joy is to contribute to a positive re-evaluation of the Schadenfroh subject or of what s/he considers his/her ingroup.

While in the two subtypes of Image Schadenfreude the focus is mainly on subject A, in Aversion and Injustice Schadenfreude the focus is on B.

- **Aversion:** This type occurs when B is subject to a negative evaluation of noxiousness.
- **Injustice:** Subject B performs an act that is considered unjust by A, but subsequently B is struck by a misfortune that "punishes" him for the injustice done.

THE SOCIAL MEDIA. A MINE FOR STUDYING EMOTIONS

To find numerous and reliable data useful to test the adequacy of our model, we used the social media, a new fundamental tool in the contemporary world, that have transformed society and the emotional life of individuals. Social media encourage users to express their feelings, moods and emotions, even extremely complex, often simply through the emojis of faces that go from sad to happy. Very simple emoji stimulate users to contribute more frequently by indicating how they feel about the posted contents (D'Aleo et al., 2015).

Also emotional contagion, through which positive or negative emotions are transferred across individuals, occurs in a proportion never experienced before just thanks to social media. By examining posts and comments on Facebook, Kramer (2012) found out that the more a person is exposed to positive posts and messages, the more likely s/he starts to create positive posts and comments, while the more one is exposed to negative comments and posts, the more one will tend to produce negative content.

To understand the magnitude of the social media phenomenon, it is important to specify that not only emotions but also changes in self-esteem and self-presentation were radically influenced by social platforms. Investigating how narcissism and self-esteem manifest themselves in a hundred of self-reports on social media, Mehdizadeh (2010) found that subjects with higher narcissism and lower self-esteem tend to spend more time on the social media and to produce contents in which they "promote" their own image. Understanding the nuances of schadenfreude is therefore important to understand the social dynamics in the social media era, shedding light on an emotion often left in the shade even if easily found in our daily life, especially on the internet.

For this reason, our work intends to exploit the potential offered by social platforms to draw on a pool of large contents (Glushko et al., 2008; Ley and Seitlinger, 2015) for empirical research on Schadenfreude. In the following we will take advantage of such a mine of data to carry out three studies. First, we analyze several cases of this emotion to validate the categories of Schadenfreude identified above. Then, we go more in depth in Injustice Schadenfreude analysing a peculiar case of it. Finally, we apply a lexicometric approach to other cases of the emotion, to investigate the specific differences between the Aversion and the Injustice type.

STUDY 1. TYPES OF SCHADENFREUDE IN THE SOCIAL MEDIA

To validate the typology of Schadenfreude proposed above and to assess the distribution of its types using a large body of data, we conducted a study on the expression of Schadenfreude in the social media.

Our first research questions were: (1) if the cases of Schadenfreude expressed in the social media can be adequately classified into the four proposed types; (2) what is their distribution across gender and culture; (3) whether Schadenfreude is more typically felt when the unfortunate event is caused by the victim or not.

To carry on our analysis we collected a corpus from Italian and English-speaking posts, we preferred to use our corpus that takes into account the idioms that emerged in the study conducted previously, described in section "Present Misfortune" (Cecconi, 2017), rather than a dataset available online because this study is a first step in understanding this emotion and its relevance on social media. In the future this study will be replicated by expanding the research on pre-existing datasets and therefore on a much larger corpus.

Data Collection

To obtain the highest possible amount of pertinent data, we exploited one of the most widespread indexing systems on social media, the hashtag: a word or phrase typed without spaces, preceded by the hash mark (#) used as a system for indexing contents. More specifically, through the search bars present in social media networks it is possible to search by hashtag isolating the selected topics from the multitude of available contents.

In our work we selected as our primary source the social media that first introduced and enhanced the use of hashtags: Twitter. Twitter was born in 2006 and is characterized by a maximum length for the content posted on the platform that

made it essential to develop an intuitive and effective hashtag system capable of allowing users' efficient navigation.

The first problem, therefore, was how to find the most appropriate hashtags for our work, that is, to select those that convey material expressing Schadenfreude. The hashtag selection process required a long analysis of many different possibilities as well as checking more than a thousand tweets.

First of all, we examined previous work (Cecconi, 2017) that had collected more than one hundred examples of Schadenfreude, looking for idioms connected to this emotion: for instance, idioms like *mal comune mezzo gaudio* (misery loves company) or expressions like *se l'è meritato* (He deserved it). Then, in a brainstorming with twenty native Italian speakers of different age and gender, we found the idioms related to malicious joy in Italian, to be were used as hashtag to find the relative comments. For Italian, 11 hashtag were used: #Glistabene, #Benglista (= hedeservedit); #Tistabene, #Bentista, #Vistabene, #Benvista (youdeservedit); #Benlesta, #Lestabene (shedeservedit); #Malcomunemezzogaudio (miserylovescompany), #Laruotagira (thewheelturnsforall), #Puniti (punished).

Once selected the Italian idioms to be used as hashtags, thus having at disposal a huge amount of information from Twitter, we searched for hashtags in English we considered equivalent to the Italian ones, so as to structure a comparison between the types of Schadenfreude emerging from Italian and English speakers. The selection of English hashtags required to examine more than a thousand individual tweets and resulted in the following 9 hashtags: #Sweetkarma; #Karmagotyou; #Karmafuckedyou; #Theydeservedit; #Shedeservedit; #Hedeservedit; #Servesthemwell; #Serveshimwell; #Miserylovescompany.

Finally, we searched for the hashtags involving the selected idioms on Twitter and examined the obtained tweets one by one applying the proposed model, aimed at identifying cases of Schadenfreude and their specific type.

In total, from the hashtags examined we extrapolated 361 cases of Schadenfreude posted by 179 females, 174 males, and 8 individuals whose gender could not be identified.

From the Italian hashtags we extrapolated 185 cases of Schadenfreude, 93 posted by females, 86 by males, and 6 by subjects not identified for gender; from the English hashtags we extrapolated 176 cases of Schadenfreude posted by 86 females, 88 males, and 2 individuals not identified for gender.

Data Analysis. Cases Classification

As a first step of our analysis, the 361 cases of Schadenfreude were classified in terms of the types presented in section "Categories of Schadenfreude" (Compensation, Identification, Aversion, Injustice), but also in terms of the type of unfortunate event that struck B, identifying if it was, from the point of view of subject A:

(a) An accidental misfortune (i.e., one totally independent on the action of B: for example *B parks in a forbidden carpark and a vase of flowers falls on his head*);

(b) A self-caused misfortune (i.e., a misfortune in some way dependent on the action of B: *B parks in a forbidden stop and receives a sanction for his infringement of the law*).

Once the classification process was completed by one of the authors, an external judge examined 80 tweets (40 Italian and 40 English) previously subdivided into 20 cases of Compensation, 20 of Identification, 20 of Injustice, and 20 of Aversion, distinguishing 32 cases of provoked misfortune and 48 cases of accidental misfortune. The second judge was not aware of the number of cases of each type. All the cases collected, finally, were coded and analyzed by SPSS to identify possible relations between factors such as gender and the Schadenfreude typology.

The analysis of the two independent judges (one author and one external judge) showed a concordance of 0.975 and a Cohen's K of 0.96 concerning the classification into the four types, and a concordance of 0.825 and a Cohen's K of 0.623 concerning the classification of B's misfortune as accidental or provoked.

Results—Model Validation

Out of the 361 online comments, respectively 51.25% Italian (185) and 48.75% (176) English tweets, 21.61% (78) cases were classified as Compensation Schadenfreude, 13.58% (49) as Identification, 36.56% (132) as Aversion, and 28.25% (102) as Injustice Schadenfreude. The four types therefore appear exhaustive: they are distinct from each other, and cut across accidental and provoked misfortunes.

Schadenfreude in Italian and English Speakers

Using SPSS, data were cross-referenced between the four types of Schadenfreude (Aversion; Identification; Injustice; Compensation) and the language used (Italian; English). A significant difference [$\chi^2(361) = 32{,}69$; $P < 0.000$] emerges between Identification and Compensation Schadenfreude: Italians mention more cases of Identification, 21.62% (40) compared to the 5.11% (9) of the English, who on the contrary mention more cases of Schadenfreude for Compensation than Italians, 31.25% (55) vs.12.43% (23), respectively. Schadenfreude for Aversion, instead, seems to be the most common type for both languages: 35.80% (73) of the English and 37.30% (69) of the Italian cases. Injustice in English posts, 27.84% (49), is slightly less frequent than in Italian posts, 28.65% (53) (**Figure 2**).

Schadenfreude and Misfortune

The chi square analysis related the four subtypes of malicious joy to the causes of misfortune (self-caused vs. accidental) revealed significant differences [$\chi^2(361) = 90.66$; $P < 0.000$]: first of all Schadenfreude for Compensation combines more frequently with episodes of accidental misfortune: out of the 78 cases 91.03% (71) is due to accidental misfortune while only 8.97 (7) to provoked misfortune. The Injustice type instead more often corresponds to provoked misfortune: out of 102 cases of Injustice, 78.43% (80) is due to provoked misfortune while only 21.53% (22) to accidental misfortune (**Figure 3**).

On the basis of the first results (**Figure 2**) that pointed out how language is significant, we then applied a chi square analysis on the percentages emerging by crossing the samples of Italian

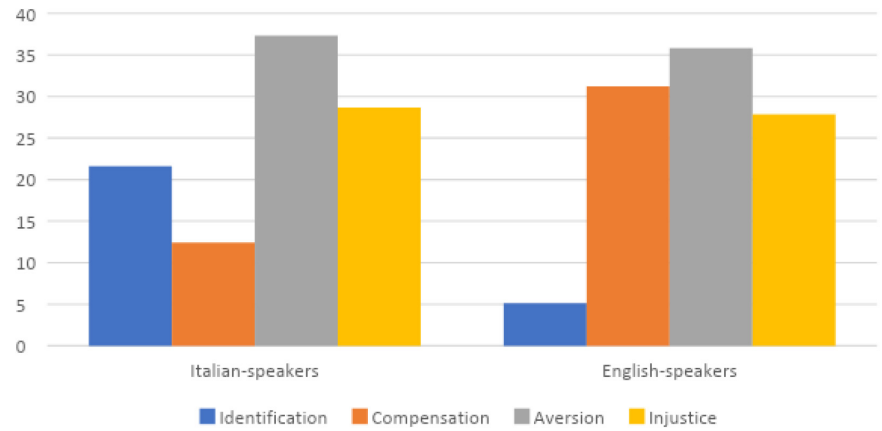

FIGURE 2 | Schadenfreude types * language.

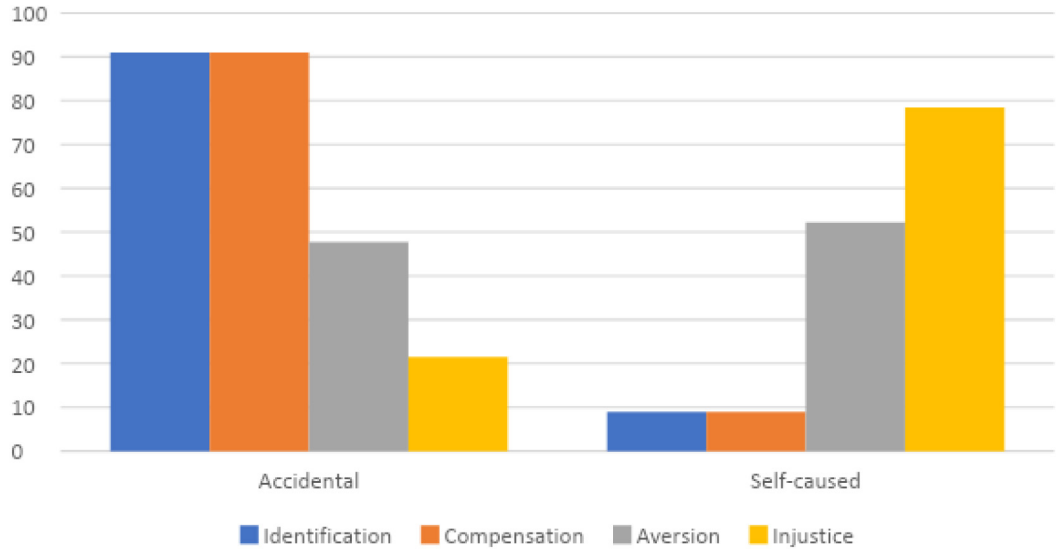

FIGURE 3 | Types of Schadenfreude and types of misfortune.

and English comments with the types of Schadenfreude and types of misfortune; also in this case results are significance for Italian [$\chi^2(185) = 31.95$; $P < 0.000$] and English comments [$\chi^2(176) = 61.15$; $P < 0.000$; **Figures 4**, **5**].

By comparing Italian and English posts as to the accidental/self-caused misfortune, it results that Aversion Schadenfreude in both groups is quite balanced between accidental and self-caused events (in Italian 44.93% accidental and 55.07 self-caused; in English 49.20% accidental and 50.80% self-caused events); the Injustice type, as obvious, is due in both much more to self-caused than to accidental facts (in Italian 18.87% accidental and 81,13% self-caused; in English 22.45% accidental and 77.55% self-caused); for Compensation Schadenfreude, Italians attribute the misfortune more to accidental (86.96%) than to self-caused events (13.04%), while English comments never attribute it to self-caused ones. But the most striking difference is that Identification Schadenfreude in Italians is triggered almost evenly by both types of causes(52.5% accidental and 47.5% self-caused), whereas for English speakers this subtype is much more typically triggered by accidental (90%) than self-caused misfortunes (10%).

STUDY 2. INJUSTICE SCHADENFREUDE IN THE BREXIT CASE

In a second study we devised to focus on one specific type of the emotion: Injustice Schadenfreude. To do so, we selected several hashtags related to a case that triggered this subtype worldwide: Brexit—the United Kingdom's decision to leave the European Union, which was seen by many people as an unjust action against Europe. However we also took advantage of this new study to more clearly set the differences

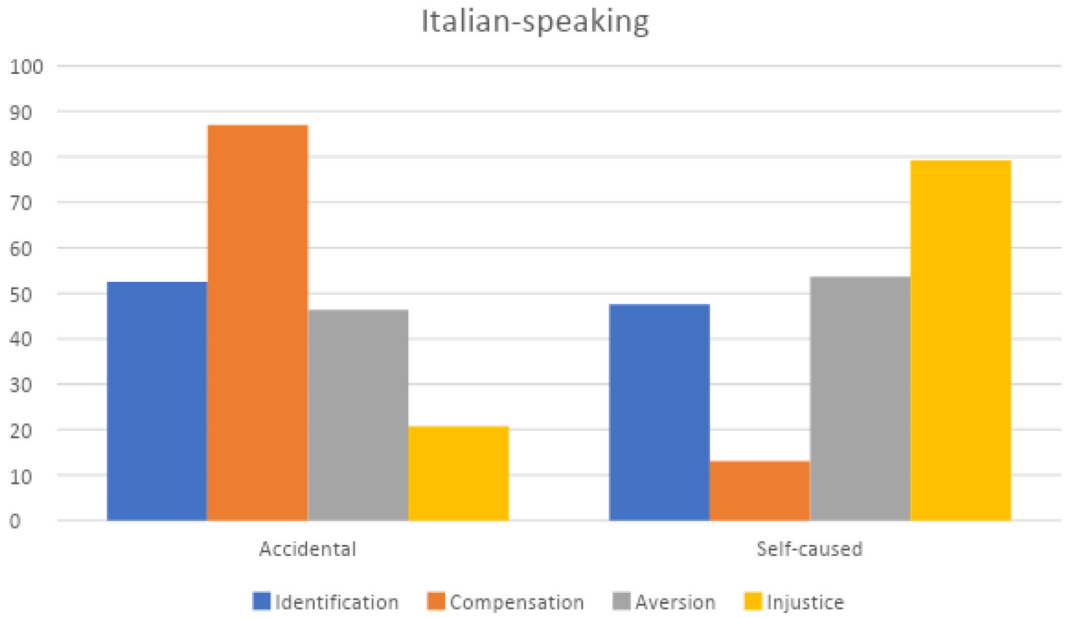

FIGURE 4 | T ypes of Schadenfreude and the type of misfortunes in Italian posts.

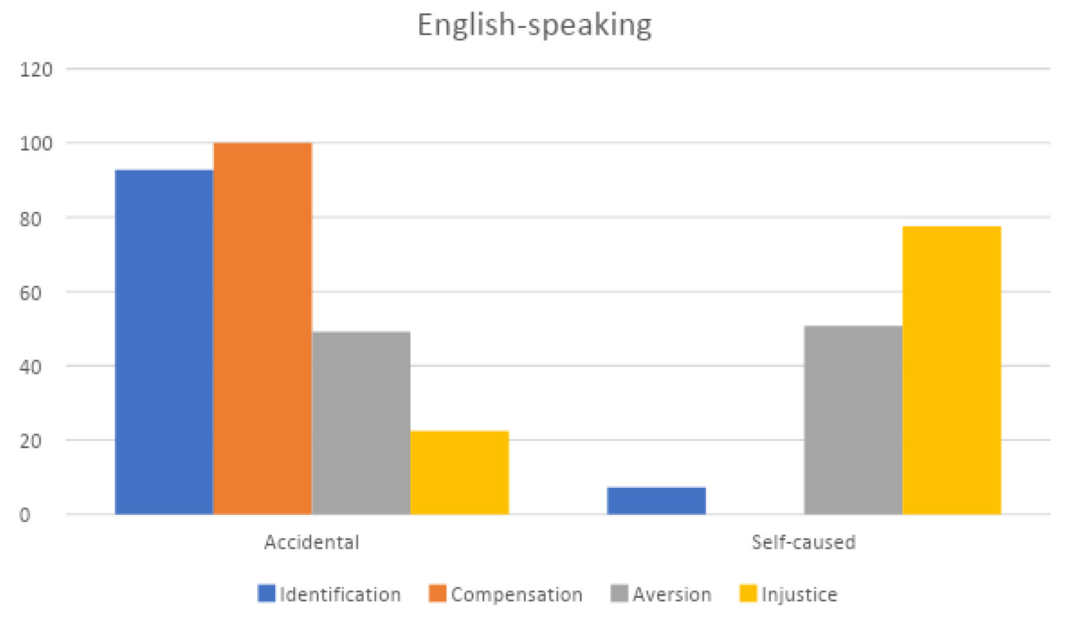

FIGURE 5 | Types of Schadenfreude and types of misfortunes in English-speaking posts.

between Schadenfreude and other positive emotions, namely pure joy and pride.

Data Analysis

In this case, a search through hashtags took into account posts not only from Twitter, and gave as output hashtags such as #Brexit #Brexitshambles, #Brexitchaos, and #Brexitkarma. Among these, the hashtag #Brexitkarma proved to be particularly prolific: the concept of karma, today universal, worked as a catalyst for posts by people who saw the misfortunes suffered by the United Kingdom as a punishment following Brexit, as if karma were really punishing English people.

From the data collected we extrapolated 166 cases that aroused our interest. In particular, we found 55 cases of positive emotions (33.13%) and 111 cases of Schadenfreude (66.87%). The other positive emotions were identified as pride (13.25%) and pure joy (19.88%), and their clear differences were highlighted compared to Schadenfreude's cases: some examples below show

the differences in terms of message and type of words used in the positive emotions compared to the cases of malicious joy:

Pride: "Great day to be #British #proud #brexit."

Pure Joy: "I'm ecstatic. . . #out #out #out Honestly, I didn't think It would happen, but it did!!! #Sohappy #Brexit #Leave #wtf"

Schadenfreude: "You vote for idiocracy, you get idiocracy. #Brexit"

Due to the numerical scarcity and the scarce relevance in this study we omitted the data related to positive emotions and focused on cases of Schadenfreude.

From the hashtags related to Brexit we extrapolated 111 cases of Schadenfreude posted by 32 females, 71 males, and 8 individuals not identified for gender. The hashtags used were #Brexit #Brexitkarma and #Brexitshambles, searched on Facebook, Instagram, and Twitter.

About the Schadenfreude in the Brexit corpus, the features examined were the following:

(a) whether the emotion expressed could really be classified as Injustice Schadenfreude;
(b) the country of the author of the tweet
(c) the field of the occurred misfortune (Sport, Nature, Politics and society, Economy).

Results

The 111 cases of Schadenfreude about Brexit were all classified as cases of Injustice Schadenfreude. As to the origin of the authors of the online comments, 67,57% (75) are from the United Kingdom, but comments come from all over the world, like the United States or Australia. In particular we have 13.51% (15) authors from the United States, 2.71% (3) from Italy, 2.71% (3) from Lithuania, 1.80% (2) from France, 1.80% (2) from Ireland, 1.80% (2) from Sweden, 1.80% (2) from Germany, 0.90% (1) from Belgium, 0.90% (1) from Guyana, 0.90% (1) from Holland, 0.90% (1) from Australia, 0.90% (1) from Canada, 0.90% (1) from, Portugal, and 0.90% (1) from South Africa.

By classifying the comments according to the field of the misfortune, we identified the following categories:

- 64.86% (72) misfortunes in the field of sport (football defeats, etc.);
- 19.82% (22) misfortunes related to politics and society (embarrassing or difficult situations that affected VIPs or politicians);
- 13.51% (15) economic misfortunes (related to currency devaluation or economic problems);
- 1.81% (2) misfortunes related to natural events (bad weather or other natural accidents).

An interesting result concerning the field of the misfortune is that in 64.86% of cases Schadenfreude is expressed in relation to a sport event (a catalyst event is the exclusion of the United Kingdom from the European championship, a football tournament, following the defeat of United Kingdom by Iceland). What is surprising is that no actual or even apparent connection is necessary, for Injustice Schadenfreude to occur, between the misfortune (exclusion from sport competition) and the event of which someone is considered guilty (Brexit).

Furthermore, it emerges that the onset of malicious joy is not limited only to those directly involved, but can also extend very far: we recorded several comments from non-European countries such as the United States, Canada, and Australia; therefore, geographical or cultural proximity does not seem necessary to feel Injustice Schadenfreude, nor does a factual closeness seem to be necessary between the unjust act committed and the misfortune suffered. Injustice Schadenfreude, which can instead be catalyzed by events of great importance and of great global impact, seems very close to the idea of karma in that whatever the unjust action you did, and whatever bad event occurred to you later appears as a retaliation for your previous act.

STUDY 3. A LEXICOMETRIC ANALYSIS OF INJUSTICE AND AVERSION SCHADENFREUDE

The goal of Study 3 was to deepen the difference in expression between Injustice and Aversion Schadenfreude. To obtain a wider corpus for our analysis, we implemented the corpus of Study 1 with further cases of Schadenfreude for Aversion and Injustice in Italian, using the same hashtags as before and another event as a catalyst for new pertinent comments: the fire that struck the cathedral of Notre Dame in Paris. The numerous posts expressing Schadenfreude triggered by this event were mainly elicited by a sense of revenge of Italians for the previous harsh comments that had been published by French newspapers and cartoonists (e.g., the satiric journal Charlie Hebdo) concerning two tragic events in Italy: the earthquake of August 2016 in Amatrice, and the fall of Ponte Morandi—a bridge in Genova—in 2018. Once excluded the few examples of Compensation and Identification types, the corpus included 294 cases of Aversion and 487 cases of Injustice, in total 3620 occurrences with 12003 different words.

Data Analysis

An automatic quanti-qualitative analysis was performed on the collected tweets by TalTac (Trattamento Automatico Lessicale e Testuale per l'Analisi del Contenuto, i.e., "Lexical and Textual Automatic Processing for ContentAnalysis," Bolasco et al., 2016; Bolasco and De Gasperis, 2017), a software for textual data analysis based on a lexicometric approach: an application of statistical principles to textual corpora.

Textual statistics aims to extract the semantic level in a text starting from the list of words obtained by statistical analysis (Lebart and Salem, 1994).

The "peculiar lexicon" is the set of words that result over-represented in the text under analysis by comparing the corpus to an external frequency lexicon, taken as a reference model. The measure of the variance from the reference lexicon (in this case we used the *standard Italian* resources in Taltac) is represented by the standard deviation, which is the deviation between the form frequencies in the analyzed text and in the frequency lexicon.

Instead, to find the "specific lexicon" the software performs the specificities' analysis, by extracting a list of significant

words obtained by a statistical comparison between sub-parts of text according to selected variables (in our case "Aversion" and "Injustice").

Furthermore, the analysis of the "concordances" is performed: all the occurrences are listed of a specific pattern in a corpus together with its immediate co-text or linguistic context, in order to assess how a particular word is used, which words co-occur with it, and what is its meaning.

Results. The Peculiar Lexicon of Schadenfreude

First of all we extracted the peculiar lexicon common to Aversion and Injustice Schadenfreude. This analysis allowed us to identify four lexical macro-categories in the corpus:

Reference to Previous or Present Facts

A mobile category of words is common, in this corpus, to Aversion and Injustice Schadenfreude: some of the most frequent words refer to the past misfortunes of Italians, harshly commented upon by the French (*vignette* = cartoons, *terremotati* = earthquake victims, *satira* = satire, *ponte* = bridge, *crollo* = fall) others to the present misfortune of the French (*francesi* = French, *cattedrale* = cathedral, dame = Notre Dame, brucia = burns, incendio = fire). Thus, comments of Schadenfreude tend to mention both the other's misfortune that causes the emotion and the previous misdeed of the victim, for which the misfortune is seen as a punishment or anyway a reason for aversion (**Table 1**).

TABLE 1 | Reference to prior facts.

Words	Occurrences	Peculiar
Vignetta	33	1014.46
Vignette	37	880.93
Terremotati	15	460.97
Francesi	83	347.49
Cattedrale	24	300.62
Chef	7	263.40
Terremoto	26	243.90
Deriso	6	225.74
Terremoti	8	190.20
Dame	25	181.75
Satira	9	169.03
Ponte	32	168.01
Euro	9	151.08
Brucia	10	147.15
Sgarbi	4	122.73
Aquila	7	99.05
Incendio	7	84.85
Crollo	11	81.75
Morti	23	78.40
Italiani	20	34.59
Ladri	4	32.27
Rubano	4	26.53
Chiese	5	22.93
Rigore	5	22.17
Votato	4	15.74
Soldi	10	15.40
Acqua	7	15.01
Fondi	6	14.27
Popolo	7	14.05
Chiesa	5	8.79
Ex	6	7.21
Veneziani	4	74.88
Licenziato	7	73.78
Ricostruire	8	54.27
Francese	18	49.03
Multa	4	38.04
Vittime	8	37.70
Rubato	5	37.35
Guerra	7	6.30

Emotive Language

Other peculiar words concern aspects of the emotion felt: some relate to pleasure (*Godo* = I enjoy, contento = happy); others are expressions of approval (Brava = good). Negative emotions (dispiace = sorry) are always preceded by the negation "not" and they either have an ironic purpose or underline the commenter's distance from the French. Words mentioning mental states, like dimentico (= forget), are also preceded by the negation, underlining that the misfortune is deserved because the subject keeps in mind the other's faults in the past (**Table 2**).

Superior Cause

Another interesting category contains words referring to superior entities or events (*Divinità* = divinity, *Tragedie* = tragedies), uncontrollable by humans; but also words, idioms or sayings like "*Chi di spada ferisce, di spada perisce*" (one who of sword wounds of sword perishes) which refer to generically remembering that everything bad did in the past comes back in some way, sooner or later. Similarly other words underline how justice has finally come (*finalmente* = finally; *giusto* = right) (**Table 3**). This alludes to the idea of some Karma by which a divinity punishes past misdeeds.

Aggressive Language

Finally we identified particularly vulgar or aggressive words: foul language (*coglioni* = asshole), curses that wish bad luck (auguro = I wish) to the victim of the misfortune. We also found interesting concordances regarding the term frega (care) always preceded by negations, to make it explicit how little the pain of the other matters (I don't care) (**Table 4**). This, along with the emotive language seen above, stresses the total lack—even, the refusal—to feel empathy for the other's misfortune.

Results. the Specific Lexicon of Schadenfreude

A Lexicon of Aversion Schadenfreude

From the analysis of the collected lexicon the preferred online expressions of Aversion Schadenfreude are very strong terms such as *godo, godere* (to enjoy) normally related to intense pleasure in sexual intercourse, but here expressing the huge pleasure caused by the other's misfortune. Also, words like

TABLE 2 | Emotive language.

Words	Occurrences	Peculiar
Godo	25	941.28
Dimentico	20	221.36
Dispiace	32	145.98
Spiace	7	84.85
Bella	15	32.95
Bellissima	4	32.27
Sinceramente	7	32.02
Ansia	6	29.74
Piangere	6	28.54
Piange	4	27.84
Contento	7	27.59
Pietà	5	22.93
Brava	4	22.26
Odio	5	21.77
Gioia	4	14.41
Bravo	4	12.94
Pensiero	4	6.94
Piangono	4	56.35
Dimentichiamo	5	47.76
Aspettiamo	5	46.96
Lacrime	4	20.58
Ricorda	4	10.20
Bene	20	5.81

TABLE 3 | Superior cause.

Words	Occurrences	Peculiar
Cristianità	5	188.08
Perisce	5	188.08
Ferisce	5	132.83
Tragedie	7	102.84
Disgrazie	7	82.66
Tragedia	6	31.63
Pregare	4	31.46
Ora	36	25.80
Stavolta	4	25.60
Avrebbero	6	16.06
Finalmente	7	15.14
Fatta	7	9.32
Pagare	4	7.09
Spada	6	50.87
Divina	8	40.61
Tocca	5	18.52
Giustizia	13	17.36
Aspetti	7	10.79
Giusta	4	9.66
Aspetto	4	4.48
Giusto	4	4.41

TABLE 4 | Aggressive language.

Words	Occurrences	Peculiar
Cazzi	7	151.81
Culo	9	119.21
Frega	14	107.69
Cazzo	5	31.51
Merita	5	29.83
Auguro	4	13.78
Doveva	7	12.70
Spero	4	12.04
Buffone	4	70.54
Meritano	6	55.60
Coglioni	4	54.40
Dovete	4	16.52
Devono	6	4.58

TABLE 5 | Aversion specificities.

Word	Occurrences	Specificities	*p*-value
Goduria	7	Spec	<0.01
Godo	13	Spec	0.02
Bello	5	Spec	0.03
Quanto	9	Spec	<0.01
Doveva	5	Spec	0.03
Di più	4	Spec	0.03
Me	16	Spec	<0.01
Mi	28	Spec	0.02
Li	7	Spec	0.05
Francesi	34	Spec	0.04
Agostino	5	Spec_orig	<0.01

dovete (you must), *di più* (more) count as curses, wishing additional misfortunes; others simply appreciate the misfortunes occurred (*quanto, bello* = how, nice): often the subject ironically comments that something is "good" o "very good" just to make fun of the other. In some cases the Schadenfroh underlines one's individuality, without referring to a larger ingroup (*me, mi* = me), attacking individuals or outgroups other than himself (*li* = them). In many cases these are *ad personam* references to the physical subjects actually involved in the misfortune *(Francesi*; *Agostino*) (**Table 5**).

Here are some specific occurrences.

Goduria: A generic noun referring to an intense pleasure, often used as an exclamation, *che goduria* (what a delight!, how delightful)

- *goduria totale. Ciao omo di merda.* ("total enjoyment. Bye shitty man.")
- *che goduria quando sgarbi si becca lo schiaffone in faccia. da orgasmo. (grazie per aver caricato questo video*:) ("what a pleasure when Sgarbi gets a slap in the face. . . orgasmic. . . thanks for uploading this video:")

Godo: A generic verb mentioning an intense pleasure.

- *ci godo tantissimo.* ("I enjoy it a lot.")
- *se mio fratello viene bocciato ci godo troppo. cristo, non si merita un cazzo* ("if my brother is rejected, I enjoy it too much. Christ, he doesn't deserve a shit")

Bello: Literally "nice," used to show appreciation for someone or something.

- *il finale più bello! Ahahahahahahahahahahahahahahaha hahahahahahahah* ("The best final" Ahahahahahahahahah ahahahahahahahahahahahahahahah")
- *l'incendio più bello che io abbia mai visto. oh dio, lascia che ti dica una cosa: la gioia è piena di me* ("the most beautiful fire I have ever seen. oh god, let me tell you one thing: joy is full of me")

Quanto: "How much." In the Aversion cases it is either a signal of irony, "How sorry" or a reinforcement of the pleasure felt.

- *quanto godo!!!* ("How I enjoy!!!!")
- *quanto godo per gli stronzi milanesi e austriaci che la popolano* (How I enjoy for Milanese and Austrians assholes that populate it")

Doveva: "it should have": used mainly as an incitement wishing even worse misfortunes.

- *ce doveva sta tutta la francia dentro notre dame, merde* ("there must have been all of France in notre dame, merde")
- *gli doveva far sputar sangue vedrai come da li in poi avrebbe abbassato la cresta* ("he should have make him spit blood so you would see how from there on he would have taken himself down a peg")

Di più: "more": often used to wish more bad luck.

- *sicuramente me ne farò una ragione. ancor di più visto che è un luogo sacro ai francesi.* ("I will definitely resign to this. make a reason for it. even more since it is a place sacred to the french")
- *non va bene d'agostino doveva dargliene di più a quel cialtrone di sgarbi* ("no good d'agostino had to give him more, to Sgarbi that scoundrel")

Me; **Mi:** Literally "myself," "me," used to indicate one's individuality as opposed to the other who has suffered a misfortune.

- a me mi importa un cazzo sono cazzi vostri francesi ("I don't give a fuck, your business you french")
- mi verrebbe da dire ahahahahah. ("I would say ahahahahah.")

Li: "them": another pronoun used to set a difference between "me" and "them," just as "myself" and "me."

- *glistabene e ce li avrei mandati a mazzate sui denti. ma vabbè punti di vista* ("Theydeservedit, I would have sent them away with blows on the teeth. but oh well points of view")

Agostino: It refers to a TV show in which Roberto D'Agostino slaps Vittorio Sgarbi:

- *agostino grazie per averci regalato questo attimo di adrenalina* ("Agostino thank you for giving us this moment of adrenaline")

Francesi: Referring to the fire of Notre Dame, Italians harshly attacks the French seen as rivals or enemies.

- *che si fottano i francesi.* ("Fuck off the french")
- *i francesi non-meritano niente* ("The french deserves nothing")

A Lexicon of Injustice Schadenfreude

Regarding Injustice Schadenfreude, frequent references to superior entities like divinities, destiny, or fate ("Karma") emerge. Other words refer to the past and to unjust acts at that time committed by the victim of bad luck. *Dimentico*, always preceded by a negation, "I don't forget," emphasizes that those who have committed unjust acts in the past, *ora* (now) receive what they deserve. The justice of bad luck is also emphasized, but often in a much less harsh way than it is in Aversion Schadenfreude (*fatto* (done). Unlike Aversion, in Injustice malicious joy is grounded in a greater sense of group belonging: it is used to signal one is part of a community that has been hit in the past by incorrect behaviors of the victim of the current misfortune (noi (we). Finally, reference is made more often to events than to subjects, thus focusing on the negative events related to the victim of the misfortune *(Vignetta = cartoon; Charlie; Hebdo; Ponte = bridge; Morandi*) (**Table 6**).

Karma: This term is used to indicate how the other's misfortune was sent by fate.

- *questione di karma.* (a matter of karma)
- *il karma colpisce tutti prima o poi.* (sooner or later Karma affects everyone)

Dimentico: "I forget." Used with the negation to emphasize how one cannot forget the past unfair behavior of the victim of misfortune.

- *io non la dimentico la vignetta sul terremoto di amatrice de sta gente* ("I don't forget the cartoon about Amatrice's earthquake these people")

Ora: in the sense of "now," it contrasts the past undergone incorrect behavior of the other with his present deserved

TABLE 6 | Injustice specificities.

Word	Occurrences	Specificities	*p*-value
Karma	22	Spec	<0.01
Dimentico	20	Spec	<0.01
Ora	35	Spec	<0.01
Fatto	32	Spec	<0.01
Noi	34	Spec	0.02
Vignetta	33	Spec_orig	<0.01
Vignette	35	Spec	<0.01
Charlie	41	Spec	<0.01
Hebdo	34	Spec	<0.01
Ponte	32	Spec_orig	<0.01
Morandi	22	Spec_orig	<0.01

misfortune. In the sense of "the time" it means that finally justice has been done.

- ora prendetevi in giro da soli merdosi ("Now make fun of yourself shit")
- era ora ("It was the right time for this")

Fatto: "done": used to support the misfortune that struck the other, approving it in full and emphasizing its justice.

- *hai fatto bene, quando ci vuole ci vuole* ("you did well, when it takes it takes")
- *hai fatto la cosa giusta* ("You did the right thing")

Noi: "we": used to detach one's comment and judgment from the self only and mark it as made by some ingroup, opposed to an outgroup.

- *beh meriterebbero una vignetta ironica, come hanno fatto loro con noi* ("Well they would deserve an ironic cartoon, as they did with us")

Vignetta; **Vignette**; **Charlie**; **Hebdo**; **Ponte**; **Morandi:** words always referred to specific past events, seen as parallel to the recent bad luck that hit the other.

- *ma la vignetta sui morti di amatrice e quella sul ponte morandi? le risate dei francesi* ("What about the cartoon on the dead of Amatrice and the one on the Morandi bridge? the laughter of the French)
- *per la presunta incapacità italiana di costruire e prevenire? incapaci di tutelare un'opera così straordinaria. ora piangete come noi. e ringraziate sui che non ci sono vittime.* (for the alleged Italian inability to build and prevent? unable to protect such an extraordinary work. now cry like us. and thank that there are no victims.").

GENERAL DISCUSSION

The research issues of our three studies generally obtained positive and interesting answers. In our first study we did not resort to crowdsourcing, as recommended by Tsapatsoulis and Djouvas (2017) and Founta et al. (2018) due both to the preliminary status of this first study, and to the difficulty of clearly explaining not only the conceptual differences among the sub-types, but even the very definition of Schadenfreude, which does not even have a distinct name in many languages. Yet, through classification by two independent judges, the typology presented was validated.

No significant difference for gender resulted from the study; this means that the feeling of Schadenfreude and its subtypes cut across male and female subjects.

Instead, some cultural differences emerge in the subtypes between Italian and English comments (we can see all English-speaking tweets, whether from Australia, United States or United Kingdom, as representative of a same or very similar culture).

Aversion Schadenfreude does not significantly differ between the two cultures, but an interesting distinction emerges in the two subtypes of Image Schadenfreude: specifically, Identification Schadenfreude is quite frequent in Italian tweets while it is almost absent in English ones; but the situation is completely reversed when it comes to Compensation Schadenfreude, massively present among English speakers and in much lower quantities among Italians.

This clear-cut difference might be accounted for by a cultural difference between Italians and English speaking subjects in terms of the classical distinction by Hofstede (2001) between collectivistic and individualistic cultures. In fact, if Italians are more keen to identification Schadenfreude than the English speaking are, the former must have a higher tendency to identify with their in-group and to feel more positive emotions when it does better than the out-group, whereas English-speaking subjects, who feel more Compensation Schadenfreude, seem to take more pleasure out of the re-evaluation of their own image or self-image, a similar distinction can be found in Anderson (1999) and Fernández et al. (2005).

Such an account is somehow confirmed by the results on the causal attribution of the misfortune by the two cultural groups. The fact that the few English feeling Identification Schadenfreude typically attribute the other's misfortune to accidental causes—an external attribution—seems to imply that the affective involvement of these subjects in their ingroup is not that high. Generally, when negative events occur, due to the actor-observer bias (Jones and Nisbett, 1971), a well-adapted subject's attributions are external when s/he is the actor, and internal when s/he is the observer, while the reverse is the case for pessimistic or depressed subjects. Here the English with Identification Schadenfreude think that the misfortune occurred to the out-group is not their fault, but this also means that they do not credit a high merit to their own in-group. This again might stem from a more individualistic attitude of the English as opposed to Italian subjects.

Study 2, on the other hand, showed that Injustice Schadenfreude cannot be felt only by people directly affected by a previous unjust action of the victim of misfortune, and that the misfortune can relieve the Schadenfroh whatever the field of its occurrence: Sport, Nature, Politics and society, Economy.

In Study 3, from the lexical analysis of expressions of Aversion and Injustice Schadenfreude in the Italian corpus, interesting differences emerge in the words used to display these two types. Curiously enough, the terms used in Aversion Schadenfreude are more vulgar and discrediting (Poggi et al., 2011; D'Errico et al., 2012) than in the other type; the "Aversion" language is also rich in punctuation (!, ?, ...), as if underlining the pleasure experienced for the other's suffering; whereas the lexicon of Injustice Schadenfreude is more moderate, mainly referring to superior entities and past sins of the victim of bad luck. Another interesting difference is that the expression of Aversion Schadenfreude mainly uses names and pronouns referred to single individuals, whereas that of Injustice often mentions groups or first plural person (us).

CONCLUSION

We have proposed a model of Schadenfreude apt to distinguish four types of it, four reasons why people feel this

emotion: Aversion, Injustice, and Image, with its subtypes of Compensation and Identification Schadenfreude. This typology has been validated through classification of independent judges in data drawn from posts in the social media, and its analysis may shed some light on the adaptive functions of this emotion. The function of any emotion is to monitor—and to signal—the achievement or thwarting of important adaptive goals of the subject: positive emotions warn that a goal is or is likely to be achieved, negative ones, that it is or might likely be thwarted (Poggi, 2008a); and emotions can be distinguished into types based on the type of adaptive goals of humans they monitor (Poggi, 2008b). We may wonder what are the goals whose achievement is signaled by Schadenfreude. In our view, the function of both subtypes of Image Schadenfreude is to monitor the individual's goal of image and self-image; the function of the Aversion type is to monitor the goal of security; and Injustice Schadenfreude monitors the goal of justice. Compensation Schadenfreude is a kind of relief about my own self-esteem, because not only I but also the other is not perfect; in Identification Schadenfreude both my image and my self-esteem are enhanced by identification with my ingroup that finally overcome the outgroup, whether the outgroup's misfortune was accidental or self-caused. In both cases, being linked to the goal of image, Schadenfreude also bears on power comparison, signaling that our goal of not resulting less skilled, competent, smart than others is achieved.

The function of Injustice Schadenfreude is to monitor our goal of justice, to have others comply with norms as we do, and if they do not, be punished for their transgressions. Aversion Schadenfreude points instead to the goal of security: when gloating about the misfortune of someone I see as an enemy, I feel so because I cannot or do not want to interact with him/her, and the more misfortune hits him, the less s/he may have the time or the chance to hurt me.

Various research issues have been tested in three corpora of social media: in the corpus of Study 1, the adequacy of the typology was verified, and different frequencies were found of the four types between Italian and English tweets, coherent with the difference between collectivistic and individualistic cultures; Study 2 tested the role of independent events as catalyst of Schadenfreude (e.g,. sports competition); Study 3, on a corpus including the "Notre Dame" subsample, highlighted the differences between Aversion and Injustice Schadenfreude through lexicometric analysis.

Concerning the conceptual and empirical analysis of emotions, this is but a first step in the analysis of malicious joy. Other studies might be conducted to provide a more detailed picture of Compensation and Identification Schadenfreude, to deepen the specific lexicon used to talk of Schadenfreude in general and its subtypes, to investigate the subtle relationships between this and similar emotions like gloating or sadism; finally while so far we have mainly focused on the aspects of Schadenfreude as a positive emotion, the reasons for its being a sanctioned emotion, like is envy, also deserve investigation. Future studies might further investigate the differences of body and facial expression between Schadenfreude and pure joy, and among the types of Schadenfreude.

On the methodological side, the lexical analysis of posts in social media, although it can be further refined, lays the foundations for the development of the Automatic Extraction of Schadenfreude in on-line communication (D'Errico and Poggi, 2016) allowing to extract complex emotions, as done before for bitterness and acidity (Poggi and D'Errico, 2010; D'Errico and Poggi, 2014), and to detect and measure emotional hostility (D'Errico and Paciello, 2018). The extraction of a Schadenfreude lexicon when persons or groups suffer negative events might help to grasp the influence that socially relevant events have on individuals. The opportunity to distinguish the different types of Schadenfreude based on their expression, taking into account the corresponding monitored goals, would also allow us to understand what goals are most salient in people in different contexts, whether their own image, cooperation with others, justice, or simply their own individuality; this would in turn lead to a better comprehension of the internal dynamics of society in the era of social media.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Roma Tre University Ethical committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

CC contributed conception and design of the study, collected the data, organized the database, performed the statistical and lexicometric analyses, and wrote and reviewed the whole manuscript. FD'E took care of the methodology, study design, statistical and lexicometric analysis and results discussion. IP took care of the conceptual analysis and supervised the whole work. All authors contributed to manuscript revision, read and approved the submitted version.

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A Systematic Review of Personalized Collaborative Systems

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Personalization, aiming at supporting users individually, according to their individual needs and prerequisites, has been discussed in a number of domains including learning, search, or information retrieval. In the field of human–computer interaction, personalization also bears high potential as users might exhibit varying and strongly individual preferences and abilities related to interaction. For instance, there is a good amount of work on personalized or adaptive user interfaces (also under the notion of intelligent user interfaces). Personalized human–computer interaction, however, does not only subsume approaches to support the individual user, it also bears high potential if applied to collaborative settings, for example, through supporting the individuals in a group as well as the group itself (considering all of its special dynamics). In collaborative settings (remote or co-located), there generally is a number of additional challenges related to human-to-human collaboration in a group, such as group communication, awareness or territoriality, device or software tool selection, or selection of collaborators. Personalized Collaborative Systems thus attempt to tackle many of these challenges. For instance, there are collaborative systems that recommend tools, content, or team constellations. Such systems have been suggested in different domains and different collaborative settings and contexts. In most cases, these systems explicitly focus on a certain aspect of personalized collaboration support (such as team composition). This article provides a broader, concise overview of existing approaches to Personalized Collaborative Systems based on a systematic literature review considering the ACM Digital Library.

Keywords: personalization, adaptive systems, collaborative systems, CSCW, systematic review

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1. INTRODUCTION

Personalized Collaborative Systems (PCS) are a relatively young research field at the intersection between human–computer interaction (HCI), computer-supported cooperative work (CSCW), psychology, and sociology but also more technically oriented fields, such as User Modeling, Recommender Systems, Machine Learning, and Data Mining. This disciplinary breadth makes PCS highly interesting for several application and research domains, on the one hand, but harder to capture in its entirety, on the other hand. To the best of our knowledge, there is no systematic review (SR) on PCS yet, neither is there a common understanding or definition of PCS across the various communities.

In this article, we aim at (i) providing a concise overview of PCS, (ii) establishing common ground and a shared understanding based on the intersection of work in different domains, and (iii) suggesting a general definition of PCS. In order to achieve these goals, we conducted a systematic literature review (see section 2).

The following sections describe in further detail the most closely related fields behind PCS. A PCS inherently involves *personalization* as well as *collaboration* aspects. We thus provide relevant definitions related to these fields to be referred to throughout this article.

1.1. Collaborative Systems

Humans as social beings are inherently used to working together in groups. The urge to work together with others is deeply anchored in our nature and dates back at least until the prehistoric times when early hunters and gatherers saw advantages in doing these activities together to increase effectiveness, efficiency, and have safeguarding against failure. To arrive at a more precise definition of what the phrase "working together" means, we suggest the definition of London (1995) who holds that collaboration is working together *synergistically*, and therefore, differs from other forms of group work, such as coordination or cooperation. Denning and Yaholkovsky (2008) agree insofar, as they also see coordination ("regulating interactions so that a system of people and objects fulfills its goals") and cooperation ("playing in the same game with others according to a set of behavior rules") as weaker forms of working together, compared to collaboration, which they generally describe as the "highest, synergistic form of working together" and detail as "creating solutions or strategies through the synergistic interactions of a group of people."

One of the most traditional and maybe the most popular model to facilitate the description of collaboration processes is Johansen's popular time-space matrix (see Johansen, 1988). The matrix allows for a categorization of collaboration or related groupware along the two dimensions time ("*same time*" or *synchronous* vs. "*different time*" or *asynchronous*) and space ("same place" or *co-located* vs. "different place" or *remote*). For instance, a call on a video conferencing system or a brainstorming session on a shared web-based whiteboard would be classified as *synchronous remote* interaction, whereas a traditional bulletin board enables *asynchronous remote* interaction. Examples for *synchronous and co-located* interactions are interactive sessions on a tabletop computer or a large vertical shared display. A note left on a whiteboard to be read by another person at a later point in time is an example for *asynchronous, co-located* interaction.

While hunter and gatherer societies were almost exclusively restricted to synchronous, co-located collaboration (maybe apart from leaving asynchronous messages on cave walls) and even more recent settings, such as collaboration around interactive tabletops (see e.g., Rogers and Lindley, 2004; Buisine et al., 2012) were traditionally easy to classify as either synchronous or asynchronous and remote or co-located, today's flexible work environments involve settings which are best described as highly dynamic and flexible in nature, often switching forth and back between remote and co-located or synchronous and asynchronous work (often even in parallel). At the same time, recent advancements in technology have led to better support of these settings. As a consequence, this would mean that all four quadrants of the matrix might play a role in one single collaborative setting and a clear distinction is not possible anymore. Very recently, a mixed form of all these different characteristics was described as *hybrid collaboration* by Neumayr et al. (2018). Nevertheless, the distinction between *remote and co-located* and *synchronous and asynchronous* remains an important tool for describing the nature of collaboration (see e.g., López and Guerrero, 2017). The distinction, mainly between *remote and co-located*, is further used to classify papers retrieved throughout the review described in this article.

In the context of this article, we define *collaborative systems*, as such interactive systems that provide support in one form or another for collaborative use, that is, they allow and actively support the synergistical group work processes of a number of either co-located and/or remote individuals, including hybrid collaboration.

1.2. Adaptation and Personalization

According to Oppermann and Rasher (1997), there is a wide spectrum of adaptation in interactive systems spanning from mere user-initiated *adaptability* to fully system-driven *adaptivity*. Personalization has the aim of supporting individual users according to their special needs and prerequisites and can in principle be achieved through all stages of this spectrum, from merely configurable systems without system initiative to pure adaptivity without any possible user interference. For instance, Oppermann and Rasher (1997) mention automated selection of explanation granularity based on a user model in the learning system context as an example for "system-initiated *adaptivity* (no user control)." Audio adjustment and selection among various alternatives of control objects, which provide the same functionality, are listed as features of "user-initiated *adaptability* (no system initiation)." While adaptability might often have the disadvantage of a high effort that is necessary to achieve personalization, the upside is that the user is in full control. On the other hand, adaptivity needs only few cognitive resources from users with the danger of them not feeling in control of what is happening. Within the spectrum of *adaptation* (which Oppermann and Rasher, 1997 use to refer to both adaptivity and adaptability), there is a broad range of possible gradations, such as "System-initiated adaptivity with pre-information to the user about the changes" close to the system-initiated *adaptivity* extreme or "User-desired adaptability supported by tools (and performed by the system)" close to the user-initiated *adaptability* extreme. Somewhat in the middle of the spectrum, Oppermann and Rasher (1997) see "User selection of adaptation from system suggested features."

As described in Augstein and Neumayr (2019), the study of personalization in recent decades has mainly focused on the personalization of content (e.g., recommendation of items), navigation (e.g., recommendation of personalized paths through an item collection), and presentation (e.g., adaptation of input element size or selection of colors) to an individual's needs and preferences in different domains.

Popular domains are e-commerce (see e.g., Schafer et al., 2001; Paraschakis et al., 2015), e-learning (see e.g., Brusilovsky and Henze, 2007; De Bra et al., 2013), music (see e.g., Bogdanov et al.,

2013; Schedl et al., 2015), or movie recommendation (see e.g., Miller et al., 2003; Gomez-Uribe and Hunt, 2015).

In the domain of e-commerce, personalization is most commonly established through recommendation of products based on a user's past interaction with the system or a user's reported preferences. In the domain of e-learning, personalization involves recommendation of learning content based on previous knowledge and past performance. In the music and movie domain, personalization is most often seen in form of personalized recommendations of movies or other video items, songs, or artists based on past interaction (e.g., viewing or listening behavior).

Further research on personalization for the individual has been done under the notion of personalized HCI (see Augstein et al., 2019), for instance, in the concrete form of adaptive user interfaces (see Peissner et al., 2012; Park et al., 2018; Gajos et al., 2007) or personalization of input or output processes (see Augstein and Neumayr, 2019; Biswas and Langdon, 2012; Stephanidis et al., 1998). For instance, personalized HCI might include personalized arrangement of input elements on a user interface, the personalization of output modalities, or automated selection or recommendation of input devices, often considering a user's motor or cognitive impairments.

1.3. Personalization for Collaboration and the Need for a Systematic Review

All the diverse endeavors in the different domains are aimed at improving the use of the more general term interactive systems. In addition, they are united in their efforts to support an individual user as optimally as possible. *Personalization* has traditionally and commonly been inherently understood as *individualization*, that is, emphasizing aspects like modeling individual users' characteristics as profoundly as possible or tailoring content, system or user interface components to these characteristics as accurately as possible (see section 1.2).

One aspect that, however, seems to be comparably understudied lies in *personalized support of individual users as part of a group* or of the *group as a whole*. There is profound ground work for such efforts stemming from different domains, such as CSCW, psychology, or sociology. For instance, there are multiple studies on team composition and its potential effect on group work success. For example, Horwitz and Horwitz (2007) suggest teams with substantial skill diversity, Lykourentzou et al. (2016) propose team compositions based on balanced personality types, and Kim et al. (2017) present research on the effects of gender balancing in teams. Gómez-Zará et al. (2019) further suggest using a combination of several factors, such as "warmth skills" (e.g., creativity, leadership experience, and social skills), bonding, and bridging capital to arrive at good team constellations.

Yet, in our observation, only few of these findings have been taken up as a basis for automated (i.e., primarily system-driven) personalization for collaborative work (or groups in general). A second observation that motivated us to systematically review research on PCS was that related work seemed to be spread across several domains (and might thus be harder to gain an overview for researchers).

Therefore, in this article, we provide an SR of relevant literature in the ACM Digital Library (DL) in order to study personalization in and for *collaborative* systems. In this review, we do not exclude any parts of the adaptivity–adaptability spectrum, but lean more toward the adaptivity side because in collaborative systems the burden of a high cognitive load is often further increased through the social interactions that come along their usage, rendering additional configuration efforts unmanageable.

In the context of this article, we define PCS as follows: "**Personalized Collaborative Systems are systems that provide any kind of explicit or implicit personalized support for the individuals in a group or a group as a whole, to aid group processes**." Thus, systems or approaches that provide only individual support (but without a group context or collaboration aspect) as well as systems that offer collaboration tools but do not provide any kind of personalization are not PCS according to our definition.

1.4. Structure of the Article

This article is structured as follows. Section 2 describes in detail our approach to the systematic literature review comprising the planning of the review and the actual execution. Section 3 presents our main findings concerning a thematic overview, scientometrics, paper types, domains, research directions, the foundations of adaptation and personalization, and study types of the publications. In section 4, we discuss a taxonomy of personalized collaborative systems that gives an overview over the types of adaptation/personalization as well as collaboration support or tools for each of the publications, while section 5 concludes the article.

2. SYSTEMATIC REVIEW METHODOLOGY

There is an exceptionally long history of SRs in the field of medicine that dates back to the eighteenth century according to Bartholomew (2002). More recently, there have been efforts to transfer this methodology to other domains, for example, the social sciences, or business and economics with an early attempt by Tranfield et al. (2003), and finally to software engineering through Kitchenham and Brereton (2013). The main benefits of SRs are frequently identified as: (i) reduction of experimenter bias, that is, avoid preferences for certain papers or against other papers, (ii) increased repeatability/consistency of results, that is, different researchers should get the same results for the same research questions (or at least differences should be reproducible due to the detailed reporting), and (iii) auditability, that is, detailed reporting by following the methodology should make it easier to assess the credibility of the results (see Kitchenham and Brereton, 2013). The approach mentioned in this article is inspired mainly by the works of Tranfield et al. (2003) and Kitchenham and Brereton (2013), and further enriched through recent practical applications by Nunes and Jannach (2017) and Brudy et al. (2019). The reason for this is the lack of one

definitive guide to SR applicable to the field of HCI that stems from its interdisciplinary nature, connecting aspects of social sciences, psychology, software engineering, ergonomics, and further neighboring domains.

A common approach is to segment the SR procedure into several stages, such as (i) planning the review, (ii) conducting the review, and (iii) reporting and dissemination. The following sections detail on our approach of planning and conducting the review, while the remainder of the article is implicitly concerned with our reporting and dissemination.

2.1. Planning the Review

In this section, we present our main research goals and questions as well as a discussion of our choice of the literature database and the inclusion and exclusion criteria used to arrive at the final corpus of publications.

2.1.1. Research Questions

Our general research goal (provides a systematic overview of existing work on PCS) can be detailed through the following concrete sub-questions to be answered by the SR:

- RQ1: Is there research that can be categorized as PCS according to our definition (see section 1.3)?
- RQ2: What domains are relevant for PCS and what domains make use of PCS?
- RQ3: In what way (e.g., empirical study, system, or tool description) is work on PCS presented?
- RQ4: Since when (approximately) is research on PCS reported and how did it chronologically evolve?
- RQ5: Can a historical shift in terms of "human-centeredness" (e.g., related to controllability) in work on PCS be observed?
- RQ6: How can work on PCS be thematically clustered?

2.1.2. Queried Data Sources

The ACM DL[1] is a comprehensive database covering the publication years 1936 until today and was chosen *a priori* because it contains the most relevant conference proceedings and journals for the field of HCI (which broadly spans over the majority of all potentially relevant domains). Although ACM DL's scope is vast with more than 2.8 million publications in its database, it was a deliberate decision to not use an even broader database, such as Google Scholar, for the initial search, because of the danger to retrieve a much higher percentage and unmanageable amount of non-relevant publications without any further filters (e.g., concerning the publication years) and also such that are of inferior quality or not published under peer-review procedures. Also, we are aware that the selection of results retrieved from the ACM DL is most probably neither complete nor fully exhaustive. It was our aim to provide a wide-angle overview, not necessarily to uncover every existing relevant work. We believe that the ACM DL most probably provides the most diverse and broadest-possible overview, compared to other popular data sources, such as the IEEE Xplore (which in principle is also vast). Our confidence in this stems from the fact that, on the one hand, the computing community (in which work on "systems" is usually rooted) in its various facets (e.g., HCI, Artificial Intelligence, Algorithms & Computing Theory, Information Retrieval, or Logic and Computation, just to name a few of many ACM Special Interest Groups) focuses strongly on ACM-sponsored or -supported conferences or ACM journals for publishing their most important and advanced research findings. On the other hand, the ACM DL contains more journals and conference proceedings from domains that are considered interdisciplinary (e.g., with a focus on human-centered design and development) than comparable data sources like IEEE Xplore. Examples for the premier venues in related domains are the ACM Conference on Human Factors in Computing Systems (CHI), the ACM Conference on Recommender Systems (RecSys), the Conference on User Modeling, Adaptation and Personalization (UMAP), or the ACM Conference on Computer-Supported Cooperative Work and Social Computing (CSCW). Due to their immense impact, the named conference venues are often even preferred to thematically relevant journals by many researchers. As this prioritization of conference proceedings even over journal articles was often not understood by researchers of other fields, most of these conference venues have recently switched to a journal publication method instead of or in addition to conference proceedings. These facts, combined with explicitly stating in this article that we limited our SR on the ACM DL, are in accordance with the typical benefits [mainly (ii) and (iii)] of SRs as mentioned before. Also, all other SRs in our major field of research we are aware of either use the ACM DL as one of few major data sources (see e.g., Nunes and Jannach, 2017) or exclusively utilize it (see e.g., Brudy et al., 2019). Nevertheless, we initially considered using IEEE Xplore as well and we ran an *a priori* query identical to the one that was used on the ACM DL to get an overview of the characteristics and quality of the results. We quickly scanned almost thousand of the returned ∼3,000 results, and our findings there suggested an extremely high number of false positives (>95%, comparable to the expected false positive rate on Google Scholar). Also, our impression was that the potentially relevant fields were strongly limited (almost exclusively to the domain of education), whereas the initial results on the ACM DL suggested a much broader view which aligned better with our research goals (including uncovering domains in which research on PCS has been performed, see section 2.1.1).

2.1.3. Inclusion and Exclusion Criteria

Before the actual search, we established the following inclusion and exclusion criteria. The inclusion criteria can be summarized as follows and are reflected in our laborious process of search query creation as described in section 2.2.1.

- IC1: The publication contains research about a collaborative system as defined in section 1.1.
- IC2: The publication describes a personalization approach or some other kind of adaptation as defined in section 1.2.

Please note that our definition of PCS provided in section 1.3 is a bit more exclusive in nature as it considers only systems that,

[1]https://dl.acm.org/about (accessed May 14, 2020).

besides satisfying IC1 and IC2, use their personalized support to aid group processes. We deliberately chose not to add this as third inclusion criterion in order not to miss borderline cases. Instead, we considered all borderline cases returned by our query that satisfied IC1 and IC2 as potentially relevant and individually checked them based on their respective full text.

It is further important to note that only papers fulfilling both of our inclusion criteria were selected for the SR. Concerning the exclusion criteria, which are described below, we excluded publications if at least a single one of them applied.

- EC1: The publication is not relevant, because it is dealing with other topics (i.e., semantically false positives).
  - EC1a: No collaboration or collaborative system was studied or discussed in the publication (e.g., the result came up because of "collaborative filtering," although the paper is not dealing with collaboration between humans).
  - EC1b: The publication does not include any kind of system initiative; it is, therefore, situated at the far-right end of Oppermann and Rasher (1997) spectrum of adaptation. Please note that there are publications in our final dataset, where no finalized or prototype system capable of system-initiated adaptation or personalizaiton is present, but these papers concretely discuss future directions for system-initiated measures, hence, making them relevant to our research questions, such as the included publication by Sigitov et al. (2018).
- EC2: The publication language is neither English nor German.
- EC3: The publication is not a full paper, which we defined as having at least six pages in length and not identified as Demonstration, Poster, Extended Abstract, Workshop invitation, etc.—such papers were also returned in our search, although we used the refinement "Research Article" in the ACM DL.

2.2. Conducting the Review

In this section, we describe the details concerning our search query creation and detail on the results that were retrieved from the ACM DL.

2.2.1. Search Query

To obtain an overview of the relevant literature in the ACM DL without losing research due to keyword mismatches, we used an inclusive approach at first by specifying our search query to account for every conceivable combination of common synonyms or similar concepts of the two areas of interest: collaboration and personalization. However, to avoid such papers that only deal with the aspects marginally (e.g., only mention them somewhere in the full text), we decided to search for the terms in the abstracts. Due to the limited documentation connected to the ACM DL, we could only conclude from the results that in addition to the abstract, the name of the publication medium (e.g., the conference name) and the keywords were also searched. Apart from the refinement that the results should be a Research Article (in order to avoid such papers that are explicitly stored as, e.g., Panel, Poster, or Short Paper), we searched the ACM Full-Text Collection without any further filters. Consequently, no time ranges were excluded.

Our search query, which was derived from the research questions introduced in section 2.1.1, therefore, consisted of two sets of keywords. The first set (applying to IC1) included possible aspects of collaboration (such as "collaborative system," "CSCW," "CSCL," or "groupware") in different variants (such as "Computer-Supported *Cooperative* Work" or "Computer-Supported *Collaborative* Work"). The second set (applying to IC2) included possible aspects of personalization (such as "personalized" or "adaptivity") in different variants. The two sets were connected with a logical AND operator, while the elements within the two sets were connected with logical OR operators. This led to search results that contained at least one element of each of the two sets.

2.2.2. Query Results

Running our query on December 12, 2019 on the ACM DL yielded a corpus of 345 results (one duplicate leading to 344 results) containing 34 articles from journals and 310 from conference proceedings. The original corpus comprised the years 1997 through 2019. One researcher then went through this result set and judged the papers according to EC1–EC3 by reading the abstracts and having a look at the full texts in case the abstract's judgment was ambiguous. This run resulted in a set of 46 papers (13.4 %) judged as potentially relevant. After the resulting relevant papers were tagged and read more thoroughly, they were discussed by two researchers that led to the exclusion of ten papers due to EC1 (nine papers) and EC3 (one paper that was wrongly not excluded by the researcher during the initial judgments). Therefore, the final pass yielded a set of 36 relevant papers, which accounts for 10.47% of the original corpus (owing to the inclusive approach taken at first). While we selected two of the original 34 journal articles (5.88%) as relevant ones, 34 of the 310 conference papers (10.97%) were regarded as relevant. Interestingly, all of the 37 most recent publications from the year 2019 (including six journal articles) had to be excluded.

For an overview of the inclusion and exclusion process, see **Figure 1**.

One illustrative example of a conference paper that came up in the result set but was excluded due to EC1 is the CSCW conference paper by Egelman et al. (2008) and was accompanied by many similar exclusions. The paper was part of the original result set because the word "personalization" is inside the abstract (IC2) and the conference name is CSCW (IC1) (as mentioned above, the ACM DL also searches the publication name). However, the paper neither focuses directly on collaborative behavior between humans, nor does it understand personalization as we do. Instead, it mentions that family members wish for privacy and personalization for specific tasks on a shared home computer and understands personalization as customizing parts of the shared computer's software, such as customizing the individual desktop or

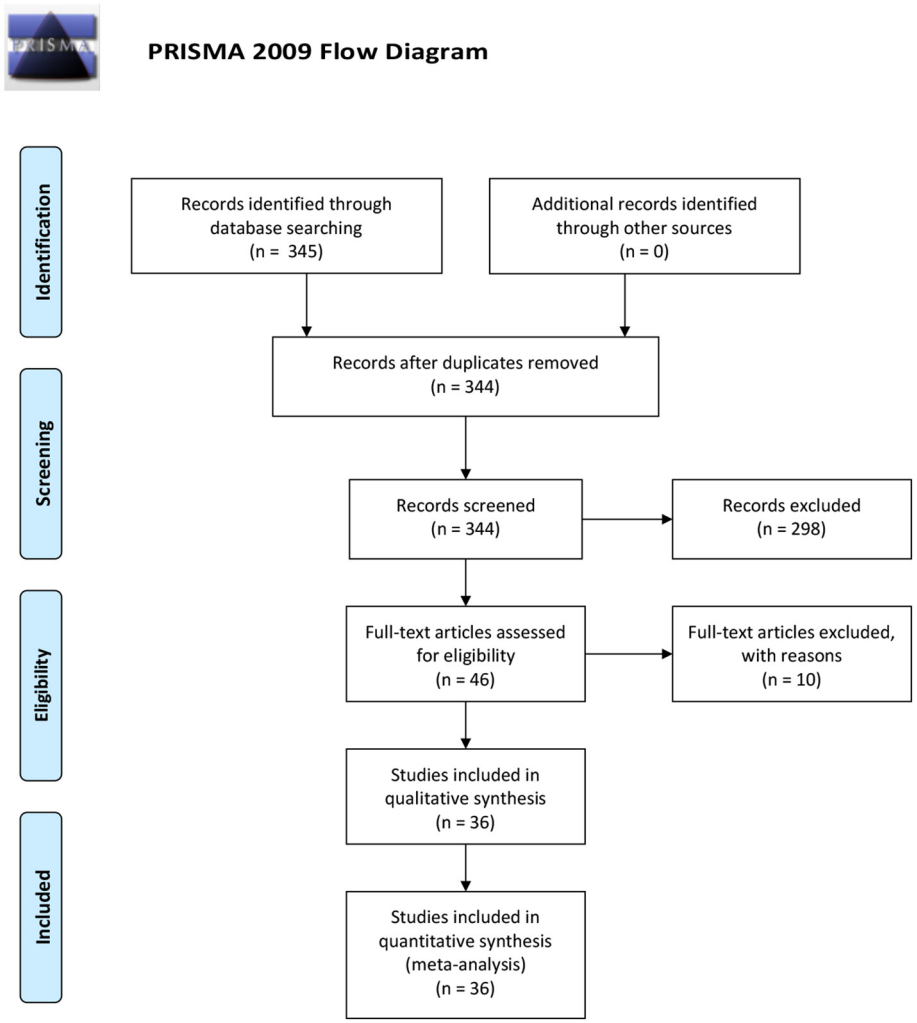

FIGURE 1 | PRISMA diagram according to Moher et al. (2009).

bookmarks as opposed to using a shared desktop or bookmarks (Egelman et al., 2008, p.674).

One illustrative example of a journal article that came up in the initial results but was excluded is from the CSCW issue of the journal *Proceedings of the ACM on Human-Computer Interaction* in November 2019 by Norris et al. (2019). In their article, they discuss the temporal coordination in collaborations of geographically dispersed teams, and by doing so, fulfilling IC1. However, no personalization or adaptivity is described, therefore, not fulfilling IC2. The article was returned in the initial set, because the keyword "adaptive" is part of the abstract in the sentence "Moreover, the adaptive practices of these broadly dispersed groups are still not well-understood" and can be regarded as a false positive that was consequently excluded.

Furthermore, it was surprising to see that only two papers from a conference venue, we initially regarded as highly relevant, namely RecSys, were part of the corpus and even those had to be excluded. The first one is Ng and Pera (2018) that—although potentially relevant—fell victim to our short paper exclusion criterion EC3 because it is only five pages in length (four pages plus references). The other one is Harper et al. (2015), which however deals with no collaborative system, and therefore, does not fulfill inclusion criterion IC1. The paper came up in the results because "collaborative filtering" is one of the meta-data keywords, triggering our search query together with "personalization," which is contained in the abstract. In conclusion, we would like to emphasize that only because a paper describes a recommender system (e.g., using collaborative filtering), this does not automatically make it a PCS, if no groups or individuals working in groups are supported.

3. RESULTS

In this section, we summarize our insights and findings obtained through the systematic analysis of the 36 papers that remained in our final data set (see section 2.2.2).

FIGURE 2 | Word cloud (generated by wortwolken.com) depicting the words most frequently used in the papers' abstracts.

3.1. Thematic Overview

Combining the contents of the retrieved abstracts and using the frequency of a term as a measure of its size yields the following word cloud (see **Figure 2**). Although the words in the cloud are dependent on the search query we ran, it is interesting to see which terms are further connected to these areas and which terms thematically unfold as common denominators by the combination of the abstracts. For this reason, no stop words were removed to paint a faithful picture of the words and phrases contained in the abstracts.

3.2. Scientometrics, Publication Date, and Venue

In **Figure 3**, we visualize the publications' current impact by depicting their citations (retrieved on May 7, 2020) in the ACM DL as well as Google Scholar. Further, we distinguish between journal publications and publications in conference proceedings and report on the publication date. In the following, we discuss our observations related to venue, publication date, scope, and impact of the publications in our final corpus.

3.2.1. Venue

Most of the papers are full papers in conference proceedings (34 out of 36), the remaining two are journal publications [ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)'16 and ACM Transactions on Applied Perception (TAP)'15]. The conferences show a large variety with only 13 papers from recurring conference venues: four papers at CHI, three at UMAP, two at CSCW, two at the ACM International Conference on Information and Knowledge Management (CIKM), and two at the ACM SIGCHI Symposium on Engineering Interactive Computing Systems (EICS). All other papers are single-shot conference venues. This maybe hints at a fragmentation and that this topic of personalized collaborative systems is not strictly rooted in a certain community but discussed here and there and everywhere. Further, it was also interesting to see that thematically highly relevant conference venues, such as RecSys, CSCW, UMAP, or CHI did not yield a higher number of relevant papers.

3.2.2. Publication Date

We can see that although we did not limit the publication date, the papers in our final corpus have all been published between 2007 and 2018, that is, all highly relevant work (according to our definition as reflected by our search query) on PCS seems to have taken place during the past decade (13 years, to be more precise). This hints at the conclusion that personalization in the area of collaborative systems is a relatively young research field.

3.2.3. Scope

As we can further see in **Figure 3**, there is only a rather small number of directly related papers per year (between 1 and 5), and there is even 1 year between 2007 and 2019 without a related publication (2010). The number of papers per year has not significantly changed since 2007 (the year of the first directly related publication). This seems to indicate that in addition to the research field being relatively young (see previous observation), it is still rather a niche field and has not received growing attention throughout the past years.

3.2.4. Impact

It is still surprising that only a few papers have more than 20 citations. The paper by Teevan et al. (2009) is the most cited (82 in ACM DL and 145 in Google Scholar) by a large margin. There are five papers with zero citations on ACM and with only one or zero citations on Google Scholar. Please note that the citations on the ACM DL and Google Scholar cannot be added up, as most citations of the ACM DL will be part of the number in Google Scholar. Interestingly, the UMAP papers while published at a well resonating conference venue are notoriously undercited with zero citations at ACM DL and combined two citations at Google Scholar. This further contributes to the impression that this field is a niche field still (see previous observation).

3.3. Paper Types

This section describes the types of publications that were part of our final corpus. We classified them according to their main contributions in the categories described below. The categories were selected based on the classification used by Nunes and Jannach (2017) in combination with the description of results by Brudy et al. (2019). Please note that most of the publications apply to more than one category (e.g., a novel tool is proposed and evaluated, leading to the categorization as tool and evaluation). In the following, we describe the categories used:

- *Ground Work*: The paper contains ground work for or contributes to lay the foundation for future efforts in personalized collaborative systems, for example, Hashavit et al. (2018), who presented a foundation for personalization in group chat through implicit user modeling (UM).
- *Evaluation*: The paper contains empirical or analytical evaluation of a system, tool, technique, or interaction/collaboration behavior in the area of personalization and collaboration.

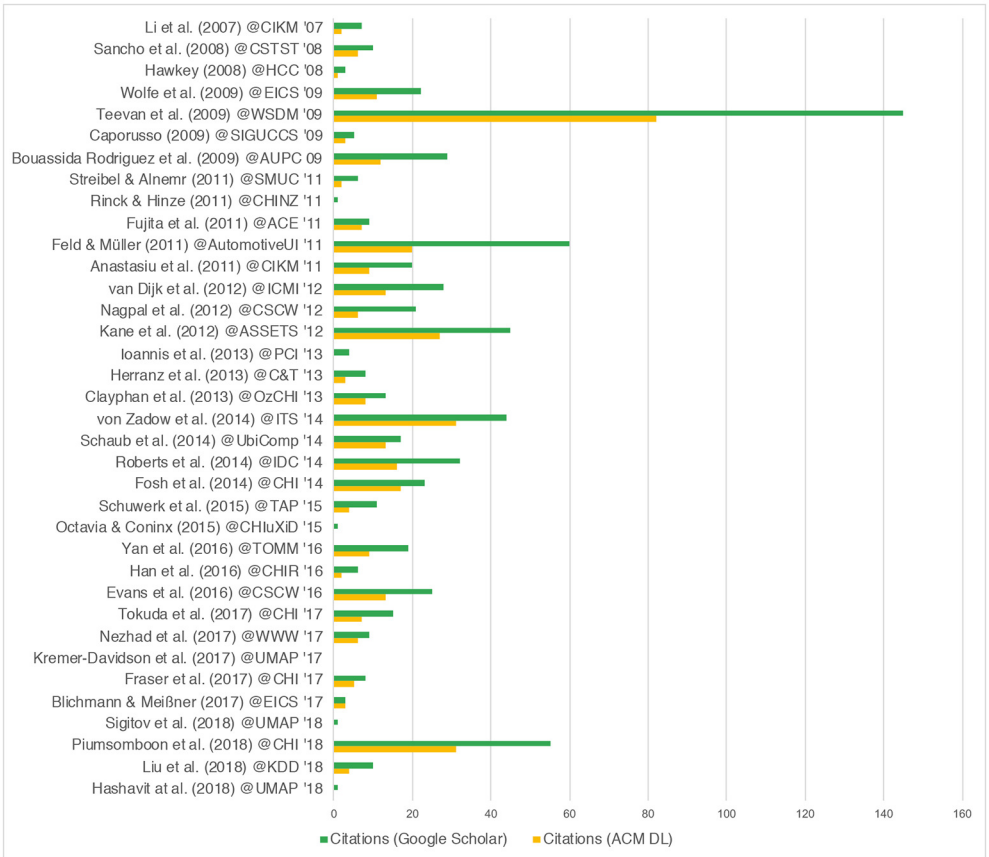

FIGURE 3 | Citations and conferences/journals (TAP and TOMM) for each paper. Citations were retrieved from ACM Digital Library (DL) and Google Scholar on May 7, 2020.

- *System*: The paper proposes or describes a (novel) system in the area of personalization and collaboration with a focus on its technical implementation (e.g., including system architecture, system components and communication between them, details related to programming language, design patterns, or even code snippets).
- *Technique*: The paper proposes or describes a (novel) technique that can contribute to enhancing personalized collaborative systems. Here, the focus is not on a certain specific tool or system (e.g., screen sharing across different device types could be studied as technique without emphasis to the concrete tool, system, or implementation behind).
- *Tool*: The paper proposes or describes a (novel) tool with a focus on its functionality (here it is more important what kind of service the tool provides for the user, how it is used and interacted with and what problems in collaboration it can help to tackle rather than how it is technically implemented).

We then analyzed and classified the papers in our final corpus according to this categorization. **Figure 4** provides an overview of the results. The figure presents the total number of papers per year, which is represented by the height of the bars as a whole and gives an impression of how these papers are distributed among the different types. For example, in the year 2007, there was one paper (y-axis) that was associated with three different types (represented by the different colors).

As can be seen from **Figure 4**, the types of the publications per year are relatively widespread over the categories we introduced. There is no obviously dominant paper type, although a slight tendency toward a focus on the *Evaluation* category can be observed. This assumption is confirmed by a more in-depth analysis of the publication contents that reveals a noticeable *transition from rather technically focused to more human-centered work*. For instance, a large part of the early publications classified as *Evaluation* papers contain algorithmic evaluations (e.g., performance tests), whereas the majority of the later publications have a clear focus on the human (e.g., user experience and user–system or user–user interaction). This ties in well with more global trend toward human-centered design (comprising also human-centered evaluation).

3.4. Domains

This section gives an overview of the different domains that were covered in the papers (see **Table 1**) and together with section 3.5 is thought to give a basic understanding of the papers' topical foci. The majority of papers (22 out of 36) discuss approaches on a general level, therefore making knowledge

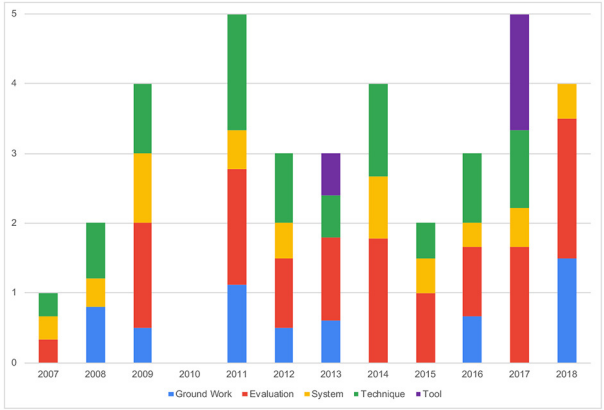

FIGURE 4 | An overview of the different paper types per year. The full bars depict the number of papers per year. Different colors of the segments within the bars give an impression about the paper types within the papers. Please note that several categories may apply to a single paper, for instance, the single paper in 2007 is associated with three categories.

transfer easier to specific application domains. The elaborated subdomains, for instance, include collaborative task solving or task management, personalized search, collaborative writing, or privacy management. In addition to the rather general findings in these papers, there are a number of papers (14 in total) that are more closely bound to certain domains, such as healthcare, education, business, or museum experience.

3.5. Research Directions

This section describes a categorization of the papers according to their most dominant research directions and provides an overview of the papers in the respective categories. Please note that the categorization is based on the authors' impression about what the major research direction was and represents just one of probably several possible solutions, which is also discussed at several occasions in the following.

3.5.1. Recommendation

We regarded four of the papers as work on recommender systems. Liu et al. (2018) describe a framework for context-aware academic collaborator recommendation based on topics and authorship of previous literature in order to solve the CACR (context-aware academic collaborator recommendation) problem. They tested a recommendation algorithm on a large-scale academic dataset with more than 3 million academic literatures and 300,000 researchers. In a machine learning approach, they used 80% of the dataset as training data and 20% for the evaluation, which showed that their algorithm was capable of outperforming several baseline methods for the prediction and suggestion of collaboration partners. In summary, this work is relevant because it contains an approach to personalization, which supports collaboration (through recommendation of people to work with).

TABLE 1 | Overview of the papers' domains.

References	Domain — Subdomain
Hashavit et al. (2018)	General — Group chat collaboration
Liu et al. (2018)	General — Academic collaboration
Piumsomboon et al. (2018)	General — Remote mixed reality collaboration
Sigitov et al. (2018)	General — Collaborative task solving
Blichmann and Meissner (2017)	General — Widget recommendation for Workspace Awareness
Fraser et al. (2017)	General — Task management for group construction work
Kremer-Davidson et al. (2017)	Business — Enterprise social network for social presence
Nezhad et al. (2017)	Business — Automated filtering of system notifications
Tokuda et al. (2017)	General — Novel display and interaction devices
Evans et al. (2016)	Education — Collaborative learning
Han et al. (2016)	General — Collaborative information retrieval/search
Yan et al. (2016)	General — Video recommendation
Octavia and Coninx (2015)	Healthcare — Collaborative rehabilitation
Schuwerk et al. (2015)	General — Shared manipulation of virtual objects
Fosh et al. (2014)	Museum — Personalized collaborative museum experiences
Roberts et al. (2014)	Museum — Collaborative interactive map exploration
Schaub et al. (2014)	General — Use of ambient calendar systems for individuals and groups.
von Zadow et al. (2014)	General — Individual interaction with large wall-mounted multiuser displays
Clayphan et al. (2013)	General — Touch identification
Herranz et al. (2013)	General — Emergency management
Ioannis et al. (2013)	Education — Collaborative learning
Kane et al. (2012)	Healthcare — Augmented and alternative communication for people with aphasia
Nagpal et al. (2012)	General — Personalized web search
van Dijk et al. (2012)	Museum — Collaborative electronic quest
Anastasiu et al. (2011)	General — Personalized web search
Feld and Müller (2011)	Automotive — Knowledge management and sharing between cars
Fujita et al. (2011)	Business/Leisure — Enhancement of f2f leisure or business communication
Rinck and Hinze (2011)	General — Collaborative (academic) writing
Streibel and Alnemr (2011)	General — Personalized breaking news network
Bouassida Rodriguez et al. (2009)	General — Technical/software architecture modeling
Caporusso (2009)	Education — Adaptive learning applications (CSCL)
Teevan et al. (2009)	Business — Personalized web search
Wolfe et al. (2009)	General — Technical/software architecture modeling
Hawkey (2008)	General — Visual privacy management in co-located collaboration
Sancho et al. (2008)	General — Ubiquitous collaborative systems
Li et al. (2007)	Business — Project management

Blichmann and Meissner (2017) propose a system that is powered by an algorithm that calculates a recommendation list of different widgets for increasing workspace awareness (concerning, e.g., who is available, or on which projects the

remote collaboration partners are currently working) for remote collaboration based on users' preferences and the current usage context. In a pilot user study described in Blichmann et al. (2015) (please note that this additional paper was not selected by our query due to missing personalization or adaptation keywords in the abstract), the workspace awareness widgets were well-received by the participants. The paper of Blichmann and Meissner (2017) is relevant according to our definition of PCS because it offers an automated, system-driven way to support workspace awareness (which again contributes to enhanced collaboration).

Yan et al. (2016) propose a novel way of video recommendation integrating information from Twitter to avoid typical problems, such as Cold Start. They do not directly discuss a collaborative system as defined in section 1.1, but after discussing the relevance we decided for inclusion in our final corpus mainly because it provides important ground work for using Social Media data (itself being an outcome of collaborative activity) to potentially jump start future recommender systems in the domain of PCS.

Li et al. (2007) suggest a system that sorts lists of activities in activity-centered groupware for remote collaboration based on their predicted priority. The authors' aim is to decrease the problem of activity overload in activity-centric collaboration environments. They evaluated their approach using log data and compared the activities opened by users to the activity's predicted priority. Their model works significantly better than the currently employed ranking system. This paper is relevant because it presents a system-driven way to personalize the selection of displayed activities in groupware. The approach thus establishes automated support for collaboration.

In essence, the papers in this section show that recommender systems can contribute to PCS in multiple ways, such as recommending potentially fitting collaboration partners (Liu et al., 2018) by providing *in situ* suggestions for improving awareness based on collaborative interaction in groups (Blichmann and Meissner, 2017), by showing that usage data can be utilized as base data (Yan et al., 2016), or by suggesting task activities in group work (Li et al., 2007).

3.5.2. User Modeling

Three of the papers in our final corpus focus on the topic of UM. Hashavit et al. (2018) aim at the reduction of the load of conversational content "in enterprise group chat collaboration tools, such as Slack" by predicting individual users' participation in conversations and present an analysis of their UM components. More precisely, they created user models from Slack channels, modeled discussion topics of interests, modeled social relationships, and assessed user model quality by its ability to predict content of interest to a user. They showed that their user model was able to predict users' participation in conversations. All of these advances are important for future PCS, as they bear the potential to decrease the complexity of collaborative UIs through personalization.

Sigitov et al. (2018) investigate collaboration processes of dyads and focus on the transitions between collaboration states (i.e., an action of user X followed by a reaction of user Y) and interferences. The authors categorize these transitions based on changes in proximity, verbal communication, visual attention, visual interface, and gestures. The findings can be considered a basis for design of intelligent user interfaces and development of group behavior models, which can then facilitate personalization for groups.

Caporusso (2009) presents novel UM approaches for adaptive learning applications where perceptual, cognitive, and attitudinal characteristics of the users are taken into consideration and are applied through users' own decisions or a self-assessment test. Regarding Oppermann and Rasher (1997)'s spectrum of adaptation, the former (own decisions) can be seen more on the side of user-initiated "adaptability," the latter (self-assessment test) is more on the system-driven side ("adaptivity"). Concerning the performance of the learners, the version dependent on users' decisions (i.e., adaptability) outperformed both the adaptivity and baseline non-adaptive versions according to their study. Their findings further show that a well-applied adaptation based on a sound user model can increase learners' performance and might in addition generalize to other domains. The paper presents measures for adaptations in learning applications that follow the Advanced Distributed Learning (ADL) paradigm, that is said to "facilitate collaborative efforts by students to investigate phenomena and solve problems" (see Fletcher et al., 2007). This paper was a borderline case due to limited collaboration context (regarding inclusion criterion IC1). We decided to include it because the author explicitly identifies his endeavors as a "personality-aware framework for ADL," thus, contributing ground work for adaptations in future collaborative learning scenarios.

The papers in the UM section hint that both single users as well as groups as a whole in collaborative settings can be supported by personalization. However, although we identified other papers also employing a user model (mostly more marginally), these three papers are in our understanding the only ones in our corpus that particularly focus on UM in PCS. This leads us to the conclusion that more effort should be put into UM for collaboration support in the future.

3.5.3. Personalizing Experiences

The personalization of experiences is in the center of three of our papers. Fosh et al. (2014) describe an approach to facilitate personalized and collaborative interpretation of museum exhibits in co-located settings. The approach is aimed at tackling all three challenges faced by designers of mobile museum guides: delivering deep personalization (see our inclusion criterion IC2), enabling a coherent social visit and fostering rich interpretation (for both see our inclusion criterion IC1). The approach includes inviting visitors to design an interpretation tailored for a friend that the group then experiences together. On a side note, it is difficult to categorize such an approach in Oppermann and Rasher (1997)'s spectrum of adaptation because technically the approach can be regarded as user-initiated adaptability, although from the receiving partner's point of view there is no personalization effort required, therefore, rendering it more

similar to (system-driven) adaptivity. The paper further describes a trial at a contemporary art gallery and concludes that the experiences were well-received and led to rich interpretations of the exhibits, however, frequently some effort was required to maintain the social relationship between the pairs.

Roberts et al. (2014) describe part of the CoCensus project, which leverages embodied interaction to allow museum visitors to collaboratively explore the U.S. census on an interactive data map in a co-located setting. Specifically, the paper reflects on the UI design strategies to encourage visitors to collaboratively and interactively interpret large data sets in a museum. The personalization here lies mainly in the creation of a customized profile that leads to the selection of a personalized slice of the census data. It can be regarded as user-driven adaptability. The authors describe the exploration of different methods to promote engagement with the data through perspective taking and to encourage collective reasoning about the data.

van Dijk et al. (2012) present the results of a study with a personalized electronic quest through a museum aimed at children between ages 10 and 12. Half of the participants used a multi-touch table at the beginning of the museum visit to personalize their quest (three to four children interacted simultaneously and chose topics of interest from the exhibition). This choice was used to generate their quest. The study investigates whether personalization of the quest affects both enjoyment and collaboration. The authors were not able to identify statistically significant differences between the conditions personalization/no personalization but their work can be regarded as ground work for future endeavors in PCS for enriching the perceptions of experiences.

Overall, the papers in this section describe efforts toward the usage of PCS in personalizing experiences and exclusively cover museum settings. Apart from other leisure activities, such as restaurant visits or vacations, it is conceivable that PCS can play an important role in serious settings to shape experiences also, for example, in the work place.

3.5.4. Adapting Interaction

Four of the papers deal with the adaptation of interaction itself. Tokuda et al. (2017) present a novel UI in the form of an adaptive fog display. The authors state that the technique can help use the screen with similar visibility for collaboration or with different visibility for personalized content and considered different 2D and 3D manipulation tasks for pairs or single users. The screen can be adjusted for the individual Zone of Comfort (i.e., the distance in which it is easy to focus one's field of view) and even if two users stand in front of the fog screen, the screens shape can be changed so that both see a good image or each one sees an individual good image (considering the Zone of Comfort). This adjustment is by now done only after user initiative but is an interesting way of adapting collaborative interaction that could in the future be fueled by adaptivity.

Octavia and Coninx (2015) report on their experiences with adapting the interaction difficulty to the capabilities of the participants in a therapy game within and between game sessions. During collaborative rehab training, the problem is that repeating the same exercises over and over—which is favorable from a medical point of view—leads to a feeling of dullness that can be overcome through social interaction. The need for personalization is grounded in the fact that collaborators have different abilities that makes it frustrating for the ones and too easy for the others. The authors propose automated (system initiated) adaptivity to solve this issue. The results are promising and show that with automatic adaptation of interaction difficulty, patients showed better progress of performance, perceived their quality of interaction to be better, and enjoyed the training sessions.

Schuwerk et al. (2015) describe the scenario of shared haptic virtual environments (e.g., two remote collaborators push a 3D virtual piece of wood on a surface with friction by using joysticks applying force at two different points) and describe and analyze the problem of communication delay (concerning the communication of digital signals). For example, if someone notices that nothing happens with the 3D virtual object when they push the joystick (due to communication delay), they instinctively push harder. Therefore, the authors propose a system-driven adaptive force feedback system to compensate for the delays. They implemented the game Jenga for their evaluation (including activities, such as cooperative pushing, pushing and pressing, and pushing from opposite sides). They used both simulated users and real users to measure the effects of communication delay. Interaction was measured and simple verbal feedback was given. They were able to show that their approach is effective in compensating adapting collaborative manipulation tasks to changing contextual influences.

von Zadow et al. (2014) discuss personalized interaction on wall-mounted displays via a personal UI in the form of a sleeve display, thereby solving the problem that personalized interaction is difficult to achieve on multi-user displays (e.g., due to a lack of readily available tracking technology as a prerequisite to identify individual users). The approach ties in with collaborative use of wall-size displays; although there is no specific collaboration support described here (this is not the focus of this paper), the approach is inherently involved in collaborative settings. The work described can also be seen as a foundation for collaboration support because what is discussed here related to personalized interaction is inherently important for collaborative interaction in the context of PCS (e.g., around questions of privacy and disclosure of personal information on shared displays).

The four papers in this category present different approaches to adaptation of interaction processes and can be regarded as subsets of personalized HCI (see section 1.2), which explicitly involve collaborative aspects.

3.5.5. Adapting UIs

The largest share of the final papers falls into the category that is concerned with adapting UIs. Piumsomboon et al. (2018) explore in their paper how adaptive avatars can improve mixed reality (MR) remote collaboration. It presents the adaptive avatar Mini-Me for enhancing MR remote collaboration between a local AR user and a remote VR user. The avatar represents the VR user's gaze direction and body gestures. The paper

further describes a user study with two collaborative scenarios: an asymmetric condition where a remote expert in VR assists a local worker in AR, and a symmetric collaboration in urban planning. They showed that using their adaptive Mini-Me avatar led to—among other results—decreases in task completion time and task difficulty, as well as increases in social presence and preference ratings.

Fraser et al. (2017) propose a system that supports co-located groups of people in assembly tasks (such as IKEA furniture) by giving personalized work instructions and subdividing the tasks based on workers' skills, dependencies between tasks, and available tools. An external dashboard display is used for a task overview. Their aim is to bring the known benefits of task management systems and interactive instructions to the scenario of co-located group construction and assembly. A between-subjects user study was conducted to find out how well the system performs as opposed to a paper-based instruction (as the control condition). The results show that the initial time for coordinating was reduced by the introduction of the system that was additionally rated positive overall, but interestingly the participants using the introduced system rated themselves less aware of what the others were doing as compared to the control condition. The authors attributed this to the fact that the participants rarely looked at the task overview (showing what the others are currently doing) because they were satisfied with and had trust in the tasks assigned to them by the system.

Kremer-Davidson et al. (2017) describe a system called Personal Social Dashboard (PSD) that was implemented and deployed at an enterprise in order to provide feedback to employees about their usage of an enterprise social network. Some scores are calculated, for example, Activity, Network (i.e., the connectedness of an employee), Reaction to employee's content, or Eminence (i.e., interaction of others with the employee). The motivation is that when users are not successfully using an enterprise social network, they become frustrated. This can be prevented by giving feedback that can guide one toward probable causes of the lack of success. PSD is envisioned as such a feedback tool. The main goal of the paper is to study if the tool is successful in raising users' social engagement and effectiveness, which the authors found evidence for. We consider this paper as relevant because the individual employees' (as part of their group of colleagues) collaborative usage of the enterprise social network is intended to be improved.

Nezhad et al. (2017) state that the most important interface for the web is the browser and that more recently, most apps work with a notification mechanism rendering it unnecessary for users to check each app for new content. However, this is again a burden on the users concerning information overload—a situation that should have actually been solved through the introduction of notifications in the first place. Therefore, they propose an automated, personalizable way of filtering the notifications based on a user's predicted interest in the notifications. The interest is inferred in an enterprise context by the number of "actionable statements," meaning words telling the user to do something (such as "send me the presentation tomorrow"). This is detected with natural language processing. The mechanism is conceived for productivity applications in this paper (such as e-mail, chat, messaging, social collaboration tools, and so on). The overarching goal is to decrease information overload caused by notifications. This is envisioned to be guaranteed in a first step through intelligent identification of pieces of content, which are of interest to a user (e.g., an enterprise worker) across conversation channels on collaboration tools (e.g., emails, chat, messaging, and enterprise social collaboration tools). In a next step, the goal is to automatically filter conversations (and therefore notifications) that the user receives, thereby offering an intelligent and cognitive user interface with reduced information load. In an evaluation they could show that their algorithm is better in accuracy and comparable in other dimensions in comparison to an alternative algorithm. This paper is relevant because it provides an adaptive mechanism that contributes to improved collaboration through personalized notifications that help employees, for example, to react faster and more effectively to their colleagues' messages.

Schaub et al. (2014) show how to provide context-adaptive privacy in an UI at the example of an ambient (i.e., wall-mounted) calendar reacting to people moving into its vicinity. Their system supports detection of registered users as well as unknown persons. Ambient awareness displays in the form of calendars aim at reducing the problems of users either having to explicitly check their individual calendars or deal with event reminders (both interrupting their primary activity). Privacy is essential here because, for example, ambient calendar displays should not show private events if this is currently not appropriate. Thus, the system detects present persons in the proximity of the display and dynamically adapts the displayed events to the privacy preferences of individual users. The paper also reports on a qualitative study with seven displays and ten users. Some selected findings state that most participants found the presence detection system and privacy adaptation to be reliable in most situations (with one exception where a participant remained standing in the doorway that caused IR sensors to trigger incorrect in and out events). Passive interactions (such as glancing at screens) were preferred over active scheduling at the display. Furthermore, the system was well-integrated into the participants' environment and participants generally felt in control of their privacy. However, participants also voiced concerns over centralized collection and aggregation of information. Most participants primarily used the calendar display as an ambient display of information (regularly glanced at the display to gain an overview of their schedule) and automated adaptations according to privacy preferences worked mostly as expected. Summing up, Schaub et al. (2014) present an interesting example of a PCS with system-driven adaptivity applied to the privacy dimension.

Herranz et al. (2013) present a survey that lays the foundations for future personalization and adaptation of messages between volunteers in emergency management. The authors aim at finding out to what extent social technologies (e.g., blogs, forums, Facebook, instant messaging, or email) could support volunteers in their work of emergency management as a means of remote collaboration. They present some design challenges, among them the personalization and adaptation of messages. There, they argue that making the messages adaptable to the particular needs of emergency situations (maybe on

an individual level) would lead to be more effective in the emergency management domain. According to their survey results, most volunteers use social technologies daily and have medium-high expertise. The participants saw two main use cases for social technology: supporting communication within the community and coordination efforts. Some others are knowledge management, or building collaborative relationships. Sending and receiving information about emergencies to and from authorities is in principal seen as positive. The paper is relevant to PCS because the survey contains ground work for categories based on which future messages in emergency management, as a remote collaborative activity, can be personalized.

Ioannis et al. (2013) provide work for adaptive CSCL and suggest showing extra guidance to encourage novice learners. More precisely, the paper discusses the addition of the adaptation pattern "Lack of confidence" to an existing web-based CSCL tool that was authored for teachers to create structured collaborative activities. The idea behind this is to support and encourage novice learners in larger groups in order to be more confident to participate, considering the context of the group (e.g., other learners' domain knowledge). This is only one example of four adaptation patterns added to the CSCL tool (the other being "Advance the Advanced," "Group of Novices," and "Assign Moderator"). The main motivation is to support teachers with flexible tools in order to design collaborative learning tasks. The aim of the paper is to describe the case of adding the adaptation pattern to the CSCL tool and therefore inviting others to do the same by adding other adaptation patterns according to their needs.

Kane et al. (2012) adapt the UI of a personal device to show a context-aware list of relevant words to people with aphasia. The augmented and alternative communication system helps people with aphasia to recall words by providing a context-adaptive word list, that is, it is tailored to the current location and conversation partner. The paper describes the design and development phase (which included collaboration with five adults with aphasia) and presents guidelines for developing and evaluating context-aware technology for people with aphasia. The paper is relevant because conversational situations can be seen as co-located collaboration while users receive personalized support.

Feld and Müller (2011) suggest an ontology describing the automotive context with a user model (containing preferences, interactions and a presentation model) and a context model (containing—among others—devices, trip information, or the external physical context). More concretely, the presentation model is thought to provide the basis for adaptations, such as informational or warning messages, or different display regions of the screen that are conceivable to consider individual passengers' backgrounds or locations. The authors want to contribute to a comprehensive, open platform for knowledge management in the automotive domain. While the models can be regarded as a basis for future adaptations, the exchange of messages (e.g., between cars or between traffic authorities and cars) can be seen as a form of remote collaboration. Finally, a joint car ride with several passengers can be regarded as a co-located collaborative setting, even more so in a possible self-driving future. By combining these two aspects, also hybrid collaboration settings can be imagined.

Fujita et al. (2011) designed, built, and evaluated a prototype system that uses ambient displays to improve communication and improve the mood, for example, through topic suggestions. Their room-shaped system enhances the communication of a group of people in a co-located setting by showing information based on sensor data measuring the current state of the participants (e.g., utterances, head positions, and hand gestures). The information is shown on the wall, the floor (both publicly available), and on personalized displays on a smartphone. The information can be, for example, visualization of participant activity or shared interests. For example, if a person sees the visualization of a person with low activity or common interests (projected on the floor with an appropriate color coding), they can approach them and talk to them to improve their mood. The overarching aim of the installation, therefore, is to enhance communication and improve the mood. Although the envisioned personal devices were not part of the evaluations, the system is a prime example of a PCS that adapts to the group as a whole by taking into account the different interests of the individuals and adapting the ambient displays on floors and walls to that.

Rinck and Hinze (2011) conceptualized, designed, and evaluated a paper-based prototype for personalized views of documents in a personal workspace in co-located co-authoring of documents. They discuss the importance of different views and show an example scenario of a scientific collaboration to co-author a paper with collaborators having different roles, goals, and according views. The aim is to find out the attitudes of the participants concerning personalized views of documents (that generalize to "information objects"). For example, they found out that users' collaboration efforts would be lessened if they would be relieved of the burden of creating their views themselves, which indicates the need for new methods and concepts of detecting and claiming authorship of text fragments or documents.

Streibel and Alnemr (2011) suggest a procedure of first discovering a trend and then estimating the reputation of the information, thus creating a reputation network. By using this network, one will be able to have a personalized version of the news based on the current trends and one's trusted network. The aim of their paper is to propose a personalized news network based on a trend estimation algorithm in combination with a context-aware reputation estimation algorithm. The collaborative aspect here lies in the contents of a user's social media channels' timelines, such as Twitter or Facebook that can be regarded as the outcome of past remote collaboration.

Hawkey (2008) presents ground work for alleviating privacy concerns in co-located settings, such as web browsing around a personal computer. It also takes into account the user's current social context, for example visual privacy can be a concern if traces of prior activities (e.g., the browsing history) are displayed that are inappropriate for the current social viewing context. The approach is based on a conceptual model of incidental information privacy in web browsers. The goal of this research is to build a predictive model of incidental information privacy that could be used by a privacy management system to adapt which traces of previous activity appear in a web browser to suit the

current social context during periods of co-located collaboration. The results of an online survey show that the predictive models presented in the paper have potential to be used in an adaptive privacy management system to provide the basis for filtering traces of browsing activity. This then can potentially help to support co-located collaboration by reducing privacy concerns.

Please note that three of the papers in this category could potentially be also categorized as recommender systems. The paper by Kane et al. (2012) could also be regarded as a recommender system in a broad sense, but we decided against categorizing it as such because the authors themselves do not regard it as a recommender system and additionally the system lacks the typical architecture and algorithms of recommender systems. Likewise, Fujita et al. (2011) describe topic suggestions that also bear resemblance to recommender systems but are not reported as such and lack typical characteristics of a recommender systems' definition. Streibel and Alnemr (2011)'s personalized breaking news network could also be seen as a recommender system in principle but in addition to our own characterization it is *not* identified as such by the authors.

3.5.6. Web Search

Four of the papers fall under the category of web search. Han et al. (2016) suggest using contextual information, such as own and partner's search history as well as explicit collaboration (e.g., chatting) to enrich collaborative information retrieval during collaborations on the same search task. The authors also present a user study with 54 participants that shows that the approach is more effective compared to those that only consider individuals' own search histories.

Nagpal et al. (2012) propose using chat data of social networks to augment search indices for personalized web search based on users' unique background and interests. Their proposed system lets users mine their own social chatter (e.g., email messages and Twitter feeds) and extract people, pages, and sites of potential interest, which can then be used to personalize their web search results. The paper also presents a user study to evaluate the approach. The authors show that their approach using four types of search indices (i.e., a user's personal email, their Twitter feed, the topmost tweets in Twitter globally, and pages that contain the names of the user's friends) to augment the results of a regular web search can lead to effective web search personalization based on collaboration and conversation data. We consider this as relevant because the potentially constant stream of collaboration and conversation data can be used to enrich the collaboration itself.

Anastasiu et al. (2011) present a framework and prototype for a clustering approach of search results based on (collaborative) user preferences edited in a shared Wiki interface. The authors motivate their work through the superiority of clusters in search result presentation over simple lists, where a lot of irrelevant singular items have to be filtered out by users. They aimed to improve the correctness and efficiency of their clustering approach and in a user test evaluated the time users needed to find a target result. According to their study, for the user effort, the clustering conditions were by far superior to the ranked list, and personalized clustering was best among them.

Teevan et al. (2009) suggest improving personalized web search based on group information. They aim to personalize web search based on a users' group characteristics and coined this process "groupize" instead of "personalize." Furthermore, they suggest combining information about group members and identified two important factors in this regard: the longevity of the group and how explicitly it was formed. The hypothesis is that groupization leads to significant improvement in the results' ranking at least in group-relevant queries, for example, during collaborative search activities in work groups. Their analysis of two different datasets containing user profile information and users' explicit relevance judgments of search results shows that groupization performs particularly well for group-related queries and task-based groups.

Concerning the papers in this section, collaborative interaction can play an important role at several stages of activities in personalized web search. It can be useful before the actual activity, mainly delivering data for personalization as in Teevan et al. (2009), Nagpal et al. (2012), and Han et al. (2016); it can be applied during a joint collaborative web search as again in Han et al. (2016), or finally afterwards as in Anastasiu et al. (2011), where preferences are edited in a shared Wiki interface both to help with search result organization and feed back to search engine utility. Overall, the five papers in this category show how aspects of both collaborative systems and personalization contribute to PCS in web search.

3.5.7. Architectures and Frameworks

Three of the papers deal with architectures or frameworks. Bouassida Rodriguez et al. (2009) describe a highly abstract and generic architecture for the future development of collaborative ubiquitous systems and consider adaptations based mainly on context changes.

Wolfe et al. (2009) suggest a notation for the description and a tool for the development of adaptive groupware systems, aiming at making the development of such systems easier. Their approach consists of letting users themselves model the applications (user-centered), abstracting low-level details (e.g., data protocols and networking protocols), and giving high-level support for run-time adaptations. We consider this a very promising and relevant approach, given that the authors' stated aim is to decrease development efforts in the domain of PCS (under the notion of "adaptive groupware systems"). To gather more information about how this approach was received (and maybe implemented), we retrieved two additional publications by the same author(s) that were not part of our corpus. One is a book chapter giving more detailed information and considering an application area of collaborative augmented reality (see Wolfe et al., 2010), and the other one which is also the most recent publication is the dissertation by Wolfe (2011). However, both are already dated now and no more recent accounts of the work or other publications by Wolfe are available.

Sancho et al. (2008) describe an architecture (as work in progress) for the development of adaptive collaborative

applications in ubiquitous computing environments. The paper proposes an ontology model containing generic collaboration knowledge as well as domain-specific knowledge, in order to enable architecture adaptation and to support spontaneous and implicit sessions inside groups of humans and devices. The aim is to define the adaptability of ubiquitous system architectures and to define adaptation models. The events that trigger adaptation actions are described as changes in the external context (e.g., user preferences, user presence and position, changes in the priority of communications) and execution context (e.g., battery level, CPU load, or available memory of a device). The authors conclude by suggesting a layered semantic-driven architecture providing implicit session management and component deployment for collaborative systems.

If we view the three papers in this category in the temporal context (time span in which we found relevant papers, 2007–2018), we see that the efforts for architectures and frameworks for adaptive collaborative applications took place rather early (2008 and 2009). It is interesting to see that this important research direction was not pursued with the same rigor since then, at least according to our final corpus of papers.

3.5.8. Miscellaneous

The remaining two papers deal with topics that do not directly fit into one of the categories above but nevertheless deal with very important issues. Evans et al. (2016) discuss the automatic detection of the quality of collaboration at the example of tabletop interaction patterns. The reliable detection of problems or breakdowns bears great potential for adapting the UI to alleviate such situations on-the-fly, or give information for later analyses of collaborative behavior. Together with the identification of users on a tabletop, which is in the focus of Clayphan et al. (2013), such efforts could lead to a personalization of collaborative experiences on many UI types currently not able to identify users out-of-the-box (i.e., who is the originator of interaction X), among them virtually every of today's touch screen interfaces.

3.6. Foundations of Adaptation and Personalization

In this section, we analyze the basis for personalization, answering the general "To What?" question raised by Brusilovsky (1998) and revisited by Knutov et al. (2009). We hereby refer to and describe the kind of data the systems derive their adaptations from or build their personalization upon. For instance, this can be elaborated by answering more concrete questions like *What were the decision criteria for the different algorithms?* or *What were the adaptations based on (e.g., based on past or current interaction with a system)?* Fink and Kobsa (2000) suggest three different categories of data that can be used for adaptations: *user data*, *usage data*, and *environmental data* (please note that in the original text on p. 217 "environmental data" are depicted as a subcategory of usage data, possibly only a mistake in the presentation, although it is later applied as a separate category in their review characterizations, for example, "Learn Sesame relies on applications for collecting implicit and explicit user, usage, and environmental data" on p. 232). This categorization is later also used by Knutov et al. (2009) who state that *user data* "points the way toward the adaptation goal," describe *usage data* as "data about the user interaction that still could be used to influence the adaptation process," and *environment data* as "all aspects of the user's environment that are not related to the UM or usage process or behavior."

We provide an overview of data categories (user data, usage data, and environment data) that form the basis for personalization in the papers of our final corpus in **Table 2**. Please note that several approaches rely on more than one category of data. In summary, 12 papers describe approaches that rely on *usage data*, 12 collect and process *user data*, and six use *environment data*. A relatively high number of 13 papers further do not use any of these data categories (yet). For three of these papers, this is due to the early stage of the presented work (using one or several of the mentioned data categories is envisioned for future applications of the described approaches). The remaining ten papers that do not rely on any usage, user or environment data either (i) describe human-driven personalization (see e.g., Fosh et al., 2014 or Roberts et al., 2014), (ii) do not yet provide adaptations but plan this for the future (or provide an infrastructure for doing so, without mentioning which kind of data the approach should later rely on) (see e.g., von Zadow et al., 2014 or Rinck and Hinze, 2011), or (iii) describe architectures or implementations of components that might be used in adaptive collaborative systems but have no relations with collecting and processing user, usage or environment data (see e.g., Sancho et al., 2008 or Clayphan et al., 2013).

3.7. Study Types

Reflecting the different paper types in our final corpus (i.e., *Evaluation*, *System*, *Technique*, *Tool*, and *Ground Work*, see section 3.3) the majority of the papers contains some type of empirical or analytical *evaluation* of a *system*, *technique*, or *tool* or describes fieldwork for the establishment of *ground work*.

Only five papers do not involve such information, mostly having done no empirical work or describing a user study in another paper outside the scope of this SR.

Concerning the different study types that were covered in the papers, we strongly relied on the authors' self-reports. For example, if the concrete method was a combination between usability test and interviews, we used the more general terms *user study*, *experiment*, or *field experiment* as it was reported in such a paper. Our aim was to make this simplification for a greater comparability of the studies and to answer the question if users were involved or if the analysis was based on an existing dataset.

In the case that users were involved (and it was not exclusively an online survey as in Herranz et al., 2013), we also categorized if this was mainly done in a lab setting or in the field. Here, we see a rather balanced picture with 14 lab studies and ten conducted in the field.

Next, we assessed if an evaluation setting was a controlled one or was rather naturalistic, according to the well-known tradeoff between *internal* and *external validity*. Please find an illustrative overview of this tradeoff we identified in our papers in **Figure 5**. The tradeoff says in a nutshell, the more factors one controls,

TABLE 2 | Overview of the "To What?" question, telling us what the systems adapt or personalize to.

References	Data category	Details
Hashavit et al. (2018)	Usage data	Behavior in group chat (Slack)
Liu et al. (2018)	Usage data	Prior authorship of literatures found in external dataset
Piumsomboon et al. (2018)	Usage data	Remote user's gaze direction and body gestures
Sigitov et al. (2018)	N/A (envisioned: usage data)	N/A (envisioned: collaboration styles and transitions)
Blichmann and Meissner (2017)	User data, usage data and environment data	Predefined preferences, interaction with a system, contextual factors
Fraser et al. (2017)	User data, environment data	Skills of group members, dependencies between sub-tasks
Kremer-Davidson et al. (2017)	Usage data	Social network activities, for example, liking, mentioning, and connections
Nezhad et al. (2017)	Usage data, user data (feedback could be regarded as preference statements)	Initial training datasets based on e-mail messages, user feedback on missing or wrong system assumptions
Tokuda et al. (2017)	User data	Preferences for personalized display regions
Evans et al. (2016)	Usage data	Touch patterns on a tabletop computer
Han et al. (2016)	Usage data	Own, collaboration partners', and teams' search or chat histories
Yan et al. (2016)	User data and usage data	Cross-network preferences are combined with observed behavior of target network
Octavia and Coninx (2015)	Usage data	Users' performance and progress in a therapy game
Schuwerk et al. (2015)	Environment data	Communication delay in client-server application
Fosh et al. (2014)	N/A	Human-driven configuration of description of artifact, style of interaction, phrasing, and music in museum visit
Roberts et al. (2014)	N/A	Human-driven profile creation, choice of colors
Schaub et al. (2014)	User data and environment data	Users' preferences and detection of persons in proximity of the display
von Zadow et al. (2014)	N/A	Provides infrastructure for future personalized interaction
Clayphan et al. (2013)	N/A	Provides an approach for vision-based user identification on tabletop computers for future adaptations
Herranz et al. (2013)	N/A	Future support for adaptive messages in emergency management is discussed
Ioannis et al. (2013)	User data	Learners' domain knowledge and communication skills
Kane et al. (2012)	User data and environment data	Conversation partner and location are considered (Wizard of Oz) to suggest words for aphasia patients
Nagpal et al. (2012)	Usage data	Social data (e.g., links and names) from email and Twitter feeds
van Dijk et al. (2012)	N/A	Human-driven personalization of museum quests for groups on children based on their thematic interests
Anastasiu et al. (2011)	User data and usage data	Personal and aggregated preferences, social tagging
Feld and Müller (2011)	N/A (envisioned: user data and usage data)	They envision preferences (that pertain to user data) and interactions (that pertain to usage data)
Fujita et al. (2011)	User data and environment data	Preferences for interest in conversation topics and sensor measurements of position of participants
Rinck and Hinze (2011)	N/A	Paper-based prototype about personalized view on documents in a personal group workspace
Streibel and Alnemr (2011)	Usage data	Content of Twitter and Facebook messages (both trend mining and reputation approaches)
Bouassida Rodriguez et al. (2009)	N/A	Adaptations based on context changes are envisioned
Caporusso (2009)	User data	User model considers personality traits
Teevan et al. (2009)	User data and usage data	Information about group members and their relevance judgments of items
Wolfe et al. (2009)	N/A	Framework for the implementation of adaptive groupware systems
Hawkey (2008)	N/A (envisioned: usage data and environmental data)	Previous activity in a web browser and users' current social context in co-located collaboration
Sancho et al. (2008)	N/A	Architecture for collaborative ubiquitous systems
Li et al. (2007)	Usage data	Interactions with a activity-centric collaboration environment (e.g., recency or frequency of updates to activity)

the higher the internal validity of an experiment (giving one the ability "to draw confident conclusions about cause and effects," see Gomm, 2008), but the less natural people as participants will behave in such situations leading to decreased external validity (meaning to what extent the experiment gives evidence about the "world outside"). Two researchers rated the study designs on a 7-point Likert scale (with 0.5 steps as minimum interval) within the two end-point options controlled (1) and naturalistic (7). In such cases where ratings differed, they discussed their assessment until a consensus was reached. Overall, all types of evaluations in this regard can be found among the papers, from strictly controlled ones, such as Wolfe et al. (2009) who

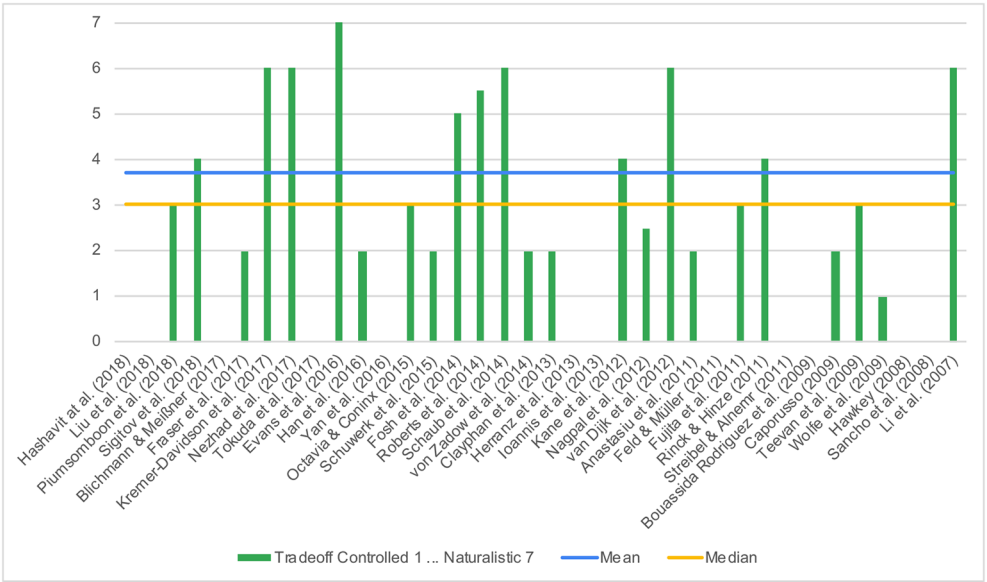

FIGURE 5 | Overview of the tradeoff between *internal* and *external validity* resulting from controlled (1) vs. naturalistic (7) study designs.

presumably evaluated one pair of users with strict tasks (i.e., person A manipulating 20 given pieces of virtual furniture on a tabletop computer, while person B viewing the changes on a PC) and measured the performance of the architecture, up to the naturalistic deployment of a tabletop computer in a classroom with flexible software that could be used alongside other activities and materials as described by Evans et al. (2016), which we regarded as most naturalistic in this context.

Finally, we coded if the study was more of a qualitative (QL) or quantitative (QN) nature, or if it was a mixed methods (MM) approach, incorporating both aspects. We see a dominance of QN approaches with 18 studies involving QN approaches, while only three studies focused on a QL approach. However, some of the studies with a MM (10 in total) approach prioritized QL.

For an overview of the different study types, see **Table 3**.

4. TAXONOMY OF PERSONALIZED COLLABORATIVE SYSTEMS

The two main aspects of this SR are collaborative systems, on the one hand, and personalization, on the other hand. In this section, we present a taxonomy (see **Figure 6**) describing the main points concerning both fields (collaborative systems and personalization) for each paper in our final corpus. We aim at giving a concise overview and brief summary of the papers that were discussed in more detail in section 3.5 and presented throughout this article concerning these two main aspects.

On the top level, the taxonomy distinguishes between collaboration scenarios of **(i)** co-located and **(ii)** remote collaboration according to a prominent way of framing the nature of collaboration (as an early discussion by Johansen, 1988 shows, see section 1.1). Apart from typically being studied separately, this differentiation of being co-located or remote has a great influence on the collaborators' interaction behavior, cognitive, and psychological factors (e.g., group dynamics) as well as on the tools and devices they usually employ, further leading to potentially different personalization and adaptation mechanisms. The decision for investigating the nature of the collaboration scenario not only in regard to co-located vs. remote but also in regard to the more recent form of hybrid collaboration (in the right-hand side segment of the taxonomy devoted to Remote & Hybrid Collaboration) was a deliberate one, because hybrid collaboration is very prevalent according to Neumayr et al. (2018) and has some special features to it that make a closer look worthwhile. However, none of the selected publications states explicitly that hybrid collaboration was studied, which might be owing to the fact that the concept was first described in 2018. Also, no mentions of partially distributed teams engaging in the collaborations were found. Interestingly, some of the papers present frameworks or ontologies (e.g., Sancho et al., 2008) that would implicitly allow for the creation of systems that support hybrid collaboration. Because it is too farfetched to interpret a "hybrid collaboration fitness" for all papers, we abstained from doing so, although we initially hoped for some insights in this regard.

Below this top level, the taxonomy has a flat hierarchy treating all items equitably. Alongside the author(s) and year of publication, one can find information about (i) the types of adaptation or personalization discussed, and (ii) the collaboration support mechanisms presented or collaboration tools used in the papers. The papers are sorted chronologically descending regarding the publication years (i.e., most recent is on the top) and alphabetically ascending regarding the first author's last name within the years.

TABLE 3 | Overview of study types.

References	Study type	Field/Lab	QL, QN, MM
Hashavit et al. (2018)	Analysis of existing dataset	–	QN
Liu et al. (2018)	Analysis of existing dataset	–	QN
Piumsomboon et al. (2018)	User study	Lab	MM
Sigitov et al. (2018)	User study	Lab	MM (focus on QL)
Blichmann and Meissner (2017)	*User study described elsewhere*	–	–
Fraser et al. (2017)	User study	Lab	MM
Kremer-Davidson et al. (2017)	User study	Field	MM
Nezhad et al. (2017)	(1) Preparatory user study, (2) Analysis of existing dataset, (3) Pilot user study	(1) No details given, (2) –, (3) Field	(1) No details given, (2), – (3) QN
Tokuda et al. (2017)	Technical evaluation	–	QN
Evans et al. (2016)	User study	Field	QN
Han et al. (2016)	User study	Lab	QN
Yan et al. (2016)	Analysis of existing dataset	–	QN
Octavia and Coninx (2015)	User study	Lab	MM
Schuwerk et al. (2015)	User study (additional simulated users)	Lab	MM
Fosh et al. (2014)	Exploratory study	Field	QL
Roberts et al. (2014)	Investigation	Field	QN
Schaub et al. (2014)	Field study	Field	QL
von Zadow et al. (2014)	User study	Lab	MM (focus on QL)
Clayphan et al. (2013)	User study	Lab	QN
Herranz et al. (2013)	Survey	–	QN
Ioannis et al. (2013)	*No empirical work*	–	–
Kane et al. (2012)	Participatory design	Field	QL
Nagpal et al. (2012)	User study	Lab	MM
van Dijk et al. (2012)	Experiment	Field	QN
Anastasiu et al. (2011)	(1) Analysis of existing dataset, (2) User study	(1) –, (2) Lab	QN
Feld and Müller (2011)	*No empirical work*	–	–
Fujita et al. (2011)	User study	Lab	QN
Rinck and Hinze (2011)	User study	Lab	MM
Streibel and Alnemr (2011)	Analysis of existing dataset(s)	–	MM
Bouassida Rodriguez et al. (2009)	*No empirical work*	–	–
Caporusso (2009)	Experiment	Lab	QN
Teevan et al. (2009)	Data collection for quantitative analysis	Field	QN
Wolfe et al. (2009)	Technical experiment	Lab	QN
Hawkey (2008)	*User study (online survey) described elsewhere*	–	–
Sancho et al. (2008)	*No empirical work*	–	–
Li et al. (2007)	Experiment	Field	QN

Overall, 15 papers belong to the co-located section of the taxonomy and 21 papers to the remote (and potentially hybrid) section, showing that both collaboration scenarios have a substantial standing in the area of personalized collaborative systems.

5. DISCUSSION AND CONCLUSIONS

In this article, we presented and discussed a systematic literature review on work related to *PCS* in the ACM DL. *A priori*, we, besides providing an overview of existing work on PCS, expected to be able to answer our concrete sub-questions as listed in section 2.1.1: (i) find out whether research on PCS according to our definition exists at all (see RQ1), (ii) identify domains relevant for PCS (see RQ2), (iii) identify ways in which work on PCS is presented (see RQ3), (iv) describe the chronological evolvement of research on PCS (see RQ4), (v) find out whether there is a historical shift in human-centeredness (see RQ5), and (vi) identify a way to cluster PCS thematically (see RQ6). Further, we wanted to analyze the scope and reach of related approaches as well as the nature of publications and reported studies.

We were able to answer all these questions, mainly as discussed in sections 3.2 (scope and reach, and chronological evolvement), 3.3 (type and nature of publications, and shift toward human-centered work), 3.4 and 3.5 (domains and research directions, and thematic clusters), and 3.7 (study types). In addition, we discussed the data the selected PCS approaches

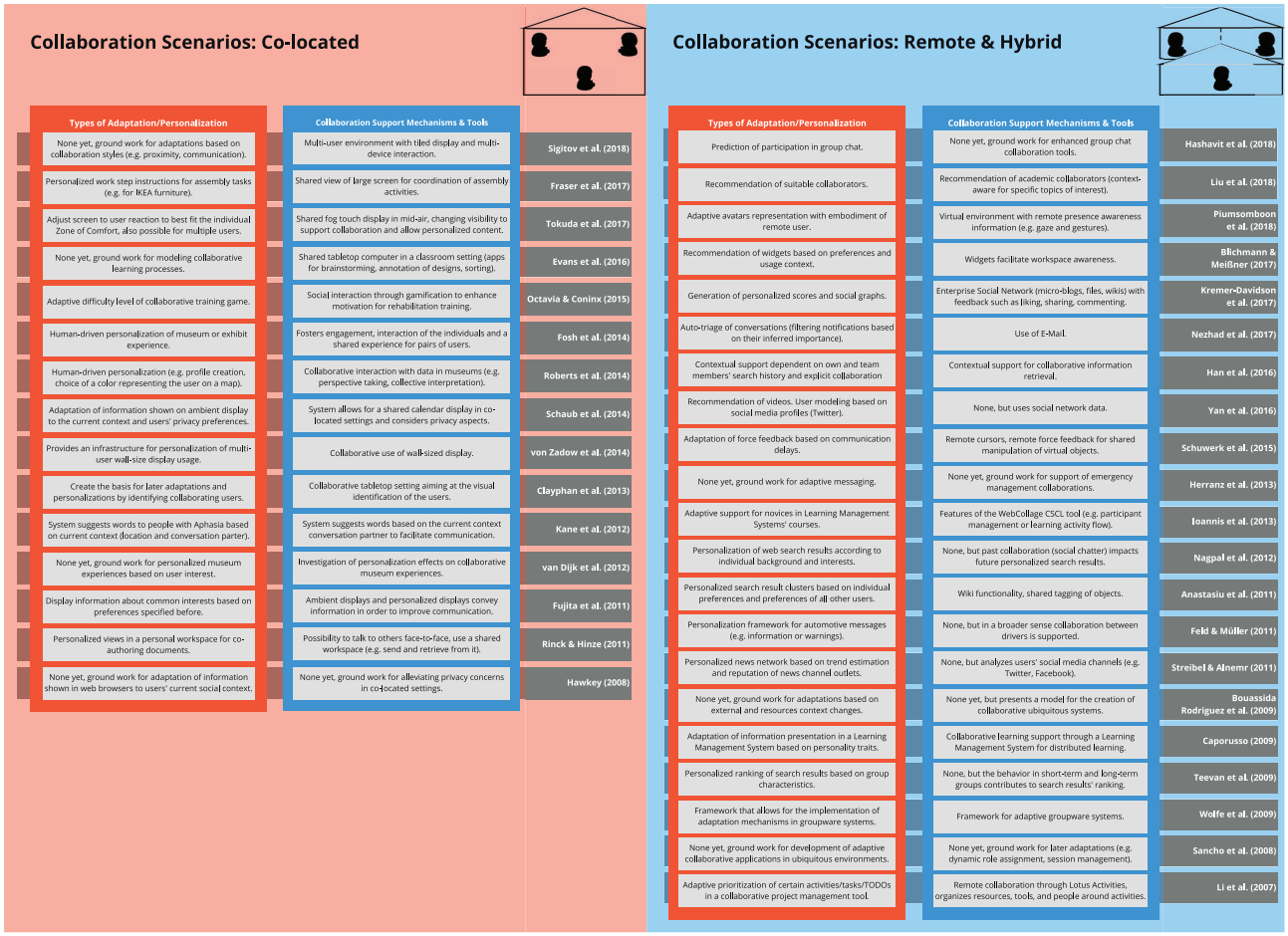

FIGURE 6 | The taxonomy of personalized collaborative systems.

rely on (see section 3.6) and introduced a taxonomy classifying the selected publications along the space-axis of the popular time space matrix (Johansen, 1988) and identifying relevant collaboration- and personalization-related details (see section 4).

In the following, we discuss potential impact and limitations of our SR presented in this article.

Our systematic search in the ACM DL yielded 36 relevant results related to PCS. This seems to be a relatively low number that might potentially be attributed to the search query used. However, it was an intentional decision to, on the one hand, include the search terms most descriptive for PCS (and their synonyms) according to our definition but, on the other hand, be sufficiently restrictive to avoid an disproportionate high number of "false positives," that is, papers that would have been returned by the search, although not relevant for our research questions. We experimented with different variants of the query before we actually conducted the review and ended up with several thousands of search results most of which were not relevant according to a random sample drawn from the result set. Even with the comparatively more restrictive query we adopted in the end, we still retrieved a result set containing almost 90% false positives. Thus, we can draw the conclusion that the 36 papers that ended up in our final corpus of papers are actually representative for the state of the art on PCS, although we acknowledge that we might not have captured all single relevant results. This is however in line with our research questions as re-listed above. Our final set of results allowed us to answer these questions.

The comparatively low number of results in the ACM DL together with other observations related to the *a priori* aims mentioned above suggests that PCS constitute a *relatively young research field* (the first relevant paper we retrieved is from 2007, although the query returned a number of results from the years of 1997–2006, which were classified as not relevant according to our criteria). The selected papers in our final corpus are relatively widespread over different conferences (and only two journals) of which only 13 papers are from recurring venues (among them CHI with four papers, UMAP with three, and CSCW with two papers). We initially expected a much higher number of relevant results from specifically the three conferences just mentioned

but also major HCI journals, such as *ACM Transactions on Computer-Human Interaction* (TOCHI). This suggests that PCS are not firmly rooted in a certain research community (yet) but rather are a *field generally interesting to different disciplines and communities*. The *impact* of the selected papers however *seems to be limited*—only a few papers in our corpus have more than 20 citations in the ACM DL or on Google Scholar, five even have zero citations (until now). The *work around PCS does not seem to be particularly active* as we identified only a few relevant papers per year (between 0 and 5).

Considering our decision to query exclusively the ACM DL that might constitute or be considered a potential limitation related to the scope of our findings, we first suggest that the ACM DL is arguably the broadest available data source among the libraries including only refereed publications, not necessarily in terms of quantity but in terms of quality in combination with scope (i.e., the covered spectrum of relevant domains). Second, we expect that while there might exist further work on PCS, which is not covered by our SR, our general findings related to relevant domains, types of publication, activity around research on PCS, and the historical evolvement should be relatively consistent across different data sources (e.g., the IEEE Xplore or Springerlink). We also performed (non-exhaustive) exemplary queries to different other data sources *a priori* (during our data source selection process) and *a posteriori* (i.e., after our SR), which suggest this observation. For instance, we scanned all 699 results returned by an identical query on the IEEE Xplore from before 2007 (i.e., the publication year of the first relevant publication identified by our SR) and found only about 10 of them to be potentially relevant (none of them was very obviously relevant, and at least six were definitely not relevant after a closer look at the abstracts). The remaining four, potentially relevant papers were all from the mid-2000s (i.e., an identical time span compared to our ACM DL results), and from domains also included in our review.

Another potential limitation could lie in the applied search strategy based on keywords connected with logical operators. This is however a common practice for SRs in our domain (see e.g., Nunes and Jannach, 2017; Brudy et al., 2019), and also recommended by the popular guidelines of Kitchenham and Charters (2007). Yet, it is possible that work not containing any of our keywords but semantically similar ones has not been found by the applied query. This potential limitation should, however, not have a major effect on any of the answers to the research questions posed in section 2.1.1.

In summary, the described observations and findings lead us to the conclusion that the field around PCS is probably still under-researched and might thus bare much untapped potential. For instance, we consider its capability to connect rather technically oriented research (e.g., on recommendation algorithms, machine learning, or UM) to strongly human-centered research (e.g., on HCI, human–human, or human–machine collaboration or even sociology or psychology) particularly promising, especially in light of the global trend toward human-centered design and development, human-centered computing, and human-in-the-loop approaches crisscross across different fields of application. Besides the overview on existing work it provides, we also consider this review a starting point for new research because it may not only help to identify research gaps in certain domains of interest but also reveal additional target domains or application fields.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

TN: first pass of data analysis, 50% of paper review, 60% of writing, and 50% of revision for this version. MA: 50% of paper review, 40% of writing, and 50% of revision for this version. All authors contributed to the article and approved the submitted version.

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Cognitive Style and Information Visualization—Modeling Users Through Eye Gaze Data

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Information visualizations can be regarded as one of the most powerful cognitive tools to significantly amplify human cognition. However, traditional information visualization systems have been designed in a manner that does not consider individual user differences, even though human cognitive abilities and styles have been shown to differ significantly. In order to address this research gap, novel adaptive systems need to be developed that are able to (1) infer individual user characteristics and (2) provide an adaptation mechanism to personalize the system to the inferred characteristic. This paper presents a first step toward this goal by investigating the extent to which a user's cognitive style can be inferred from their behavior with an information visualization system. In particular, this paper presents a series of experiments that utilize features calculated from user eye gaze data in order to infer a user's cognitive style. Several different data and feature sets are presented, and results overall show that a user's eye gaze data can be used successfully to infer a user's cognitive style during information visualization usage.

Keywords: adaptation, cognitive style, eye-tracking, human-centered computing, personalization, information visualization

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INTRODUCTION

With the proliferation of large quantities of data across all aspects of our daily lives (ranging from reading news articles to reaching critical business decisions), it has become paramount to research new paradigms to help users deal with such data efficiently and effectively. One technique that has generally proven successful in data analysis is to make use of graphical representations of data and particularly computer-generated representations. A key reason for the success of such information visualizations is the fact that they are making use of "the highest bandwidth channel from the computer to the human" (Ware, 2004), namely, the human visual system. As such, information visualization can be regarded as one of the most powerful cognitive tools to significantly amplify human cognition (Ware, 2004; Card, 2007; Mazza, 2009).

While information visualization systems have largely been successful in helping humans perceive and analyze information, they have typically been designed in a non-personalized manner, i.e., each individual user/viewer is being shown the same visualization in the same form. This nonadaptive nature of systems assumes that cognitive processing is mostly identical across humans and, therefore, that all users would equally benefit from the same visualization. However, a large body of research has found that there are significant differences among humans, particularly in terms of cognitive abilities and styles. Examples of cognitive abilities include perceptual speed ("a measure of speed when performing simple perceptual tasks") and verbal/visual working memory

("a measure of storage and manipulation capacity of verbal/visual information"). As with cognitive abilities, cognitive style has been studied extensively in psychology, and a number of different definitions, models, and tests have been proposed and developed (Hudson, 1967; Witkin et al., 1975; Kirton and De Ciantis, 1986; Riding and Cheema, 1991; Riding, 1997, 2001; Kozhevnikov, 2007). In a general sense, cognitive style may refer to "people's characteristics and typically preferred modes of processing information" (Sternberg and Grigorenko, 1997) and can hence be regarded as more of a preference ("lying at the junction between cognition and personality" Raptis et al., 2016a) rather than an ability. In the context of our paper, cognitive style refers to the field dependence–independence (FD-I) style, which distinguishes between field-dependent and field-independent people (Witkin et al., 1975). Specifically, field dependent people are theorized as having more problems in recognizing details in complex scenes, while people who are field independent can separate structures from surrounding visual context with ease (Witkin et al., 1975).

For both cognitive abilities and cognitive styles, individual differences have been shown to significantly influence user behaviors with different systems and user interfaces, including information visualization systems (Toker et al., 2012; Steichen and Fu, 2019). It can therefore be envisaged that more personalized systems (rather than the current one-size-fits-all model) could be of great benefit to information visualization users.

Besides information visualization, there are many other research fields that have explored individual user differences and personalized system designs for decades. Examples range from personalized search systems (Steichen et al., 2012), to personalized e-learning (Jameson, 2007), to adaptive Web systems (Brusilovski et al., 2007). Many of these examples have taken human-centered design approaches, whereby individual human differences are taken into account to develop systems that adapt to each individual person. Specifically, the two main steps to approach such a design are typically to (1) infer individual user characteristics and (2) provide an adaptation mechanism to personalize the system to the inferred characteristic (e.g., through recommendations, adaptive interface changes, etc.). Similar to these examples, there have been several recent efforts in information visualization to personalize to individual users. However, such systems have primarily focused on cognitive abilities (Steichen et al., 2014; Conati et al., 2015; Raptis et al., 2016a) rather than cognitive style. Since an individual person's cognitive style has been shown to have significant effects on human performance, particularly on the processing of visual information (i.e., the main interaction mechanism with visualizations), it is important to further investigate this characteristic for adaptation.

The overall aim of our work is thus to develop the first information visualization system that adaptively supports individual users depending on their cognitive style. Specifically, this system is envisioned to consist of a two-step process. The first step is to infer an information visualization user's cognitive style based on the user's exhibited behavior with the system. The second step will then use the inferred cognitive style to make a decision on how to best support the user in a personalized manner either through recommendations of alternative visualizations or through real-time changes to the current visualizations (or the recommendation of such changes).

Some aspects of this second step have already been investigated in prior work. In particular, the prior work in Steichen and Fu (2019) investigated the idea of "adaptive overlays," where visual artifacts would be added to the user's current information visualization. Examples of such overlays included adding grid lines for providing additional structure or displaying data point values directly on the graph. Additionally, it was found that different types of overlays were preferred by individuals with different cognitive styles, hence making a compelling case for tailoring the adaptation of the visualization to each user's style.

Complementing this prior work, this paper focuses specifically on the first step, by investigating *the extent to which a user's cognitive style can be inferred from the user's behavior with an information visualization system*. Given the fact that information visualizations typically have limited interaction (e.g., using a mouse or keyboard), the specific user behavior data used for this inference will be a user's eye gaze as captured through eye tracking. This work is a direct extension of Steichen et al. (2020), with a significantly expanded literature review, additional experiments that analyze different feature sets (see No Areas of Interest, Information Searching, and Information Processing Feature Sets section) and data sets (see Data Set Split Based on Information Density section), as well as expanded discussions and conclusions of all of the results.

RELATED WORK

The study of adaptive and personalized interfaces and systems has featured in a number of different research fields over the last few decades. In fact, the adaptation to an individual user's characteristics, such as the user's abilities (e.g., cognitive abilities), preferences (e.g., personal interests), or contexts (e.g., current task), has become ubiquitous across several types of information systems, ranging from personalized search systems (Steichen et al., 2012), to adaptive e-learning systems (Jameson, 2007), to adaptive Web systems (Brusilovski et al., 2007). To achieve such personalization, researchers typically first investigate which user characteristics may have a significant influence on a user's system interaction, followed by the development of a system that can detect behaviors indicative of different levels of these characteristics. This detection/inference component is then integrated into a system that adaptively assists an individual user, for example, through personalized recommendations or adaptive interface changes.

In the field of information visualization, researchers have similarly explored the concepts of personalized systems, i.e., information visualizations that adapt to individual users and their behaviors. As part of this work, prior research has first looked at the influence of several different human characteristics on information visualization usage (Velez et al., 2005; Green and Fisher, 2010; Ziemkiewicz et al., 2011; Toker et al., 2012; Carenini et al., 2014). For example, Toker et al. (2012) explored the

effect of different cognitive abilities (including perceptual speed and working memory) and found that they indeed have some influence on a user's performance (particularly in terms of time on task) with different visualizations. Likewise, Ziemkiewicz et al. (2011) found that the human personality trait of locus of control had a significant relative influence on different visualizations, with internal locus of control participants performing worse when information visualizations employed a containment metaphor, while external locus of control participants showed good performance with such systems. More recently, additional characteristics have been found that influence visualization comprehension, such as reading proficiencies (Toker et al., 2019) and visualization literacy (Lallé and Conati, 2019).

Similar to the above studies, the human characteristic of cognitive style has been studied in terms of its influence on user performance on different types of interfaces, including information visualizations (Steichen and Fu, 2019). As mentioned in the *Introduction*, cognitive style may generally be referred to as "people's preferred modes of processing information" (Sternberg and Grigorenko, 1997), rather than an ability. Several different theories and models have been proposed (Hudson, 1967; Witkin et al., 1975; Kirton and De Ciantis, 1986; Riding and Cheema, 1991; Riding, 1997, 2001), and recent work has also attempted to unify several of these models (Kozhevnikov, 2007). One of the most prominent models of cognitive styles was introduced by Riding (1997, 2001) and Riding and Cheema (1991), who proposed that there are two main continuous dimensions by which a user's cognitive style may be defined. Firstly, the "analytic-wholist" dimension distinguishes between individuals who process information into its component parts ("analytics"), while others retain or prefer a global/overall view of information ("wholists"). Secondly, the "verbal–imagery" dimension distinguished between people who prefer to represent information through verbal thinking ("verbalizers") and those who prefer mental pictures ("imagers"). By contrast, Kirton's adaption-innovation theory (Kirton and De Ciantis, 1986) distinguished individuals on a single continuous dimension. Specifically, in this theory, some people prefer to adapt established techniques to solve a problem ("adaptors"), while others seek innovative techniques and technologies ("innovators"). Similarly, Hudson's convergence–divergence dimension (Hudson, 1967) distinguishes between people who prefer established and familiar problem solutions ("convergent") and individuals who use more creative ("divergent") techniques and thinking processes. The FD-I theory (Witkin et al., 1975) similarly distinguishes individuals on a single continuum. Specifically, it defines "field-dependent" people in terms of their reliance on external structures and directions, while "field-independent" individuals prefer autonomy and tend to be better at creating their own structure and perform restructuring. Likewise, field-independent people can visually separate structures from surrounding visual context with ease, while field-dependent people have more problems in recognizing details in complex scenes.

Since information visualizations often consist of multiple visual artifacts that create a complex overall view of data, the FD-I theory appears particularly suited for the investigation of the influence of individual user differences on the user's behavior with such systems. Moreover, since FD-I has already been found to specifically influence people's preferences with different information visualization overlays (Steichen and Fu, 2019), we hypothesize that this type of cognitive style may significantly influence a user's processing of information visualizations and that this difference may be exhibited by the user's eye gaze. Moreover, inferring a user's cognitive style along the FD-I dimension also represents a great potential for adaptation to improve system interaction, particularly since the work in Steichen and Fu (2019) found that users with different styles along the FD-I dimension may benefit from different kinds of adaptive help. The work described in this paper therefore focuses specifically on this model of cognitive style. This focus is also in line with other human–computer interaction work (e.g., in gaming or e-commerce), which similarly found that FD-I can lead to different information processing behaviors and patterns when interacting with visual interfaces (Mawad et al., 2015; Raptis et al., 2016b).

In terms of capturing or inferring user characteristics based on user interactions, prior research has explored several different kinds of behavioral data. In fields outside of information visualization, many systems typically employ interaction data such as mouse clicks or keyboard presses (e.g., result selections or query inputs in search systems Steichen et al., 2012). Likewise, if a visualization has interactive elements (e.g., zooming, panning, etc.), interaction device data can also be used (e.g., as in the interactive visualizations used in Gotz and Wen, 2009). However, given the fact that the majority of interactions with visualizations typically entail a user simply looking at a visualization without using a mouse, keyboard, or other interaction device, researchers have started to explore alternative ways to capture a user's behavior. Most promisingly, eye tracking has been shown to be a powerful tool for analyzing user attention patterns. For example, Toker et al. (2013) found several connections between different users' eye gaze behaviors and their respective individual user characteristics. Furthermore, eye gaze data have been used successfully to infer and predict user and task characteristics (Steichen et al., 2014; Raptis et al., 2017).

The work described in this paper builds on this prior research by examining the extent to which eye-tracking data can be used to infer a user's cognitive style while the user is interacting with an information visualization system (i.e., performing a task by looking at a visualization). This in turn is envisioned to be integrated into an adaptive information visualization system, which (1) will be able to determine a user's cognitive style as the user is interacting with a visualization and (2) will dynamically adapt to the user's cognitive style, e.g., through adaptive overlays as proposed in Kirton and De Ciantis (1986), or in the form of alternative visualization recommendations, as presented in Gotz and Wen (2009).

DATA COLLECTION

In order to collect sufficient data for performing cognitive style inference experiments, we first conducted an eye-tracking

user study with 40 participants. Specifically, the study involved participants performing a series of tasks with the help of simple information visualizations while their eye gaze was recorded.

Study Visualizations and Tasks

The visualizations used in the study consisted of simple bar graphs and line graphs (see bar graph and line graph examples in **Figure 1**). These graphs were chosen due to their widespread popularity across multiple domains and diverse user bases, as well as their use in prior studies involving user differences (Toker et al., 2012; Steichen et al., 2014). Note that to keep variables at a minimum, only these two graphs were used, while other graphs are left for future research. For both types of graphs, we also devised different "information density" versions, namely, "low information density" (where only two series were shown) and "high information density" (where seven or more series were shown). This variation in graphs was intended to simulate "simple" and "more complex" graphs.

Each of the graphs depicted one of two datasets from Data.gov, namely, the Diabetes Data Set[1] and the Los Angeles Crime Data Set[2] (e.g., as in **Figure 1**). The specific tasks devised for the study were based on these data sets, with participants answering sets of questions using given visualizations. These questions required participants to either give a single answer (using radio buttons) or provide a set of correct answers (using checkboxes). For example, given a visualization depicting all occurrences of different crimes for a specific year, a participant may be asked "What crimes occurred more than vandalism crimes in November?" The types of tasks were based on the taxonomy provided in Amar et al. (2005) and consisted of "Retrieve Value," "Filter," "Compute Derived Value," and "Find Extremum" tasks.

Study Procedure

Participants began by filling out a consent form, followed by a demographic questionnaire, which included age, gender, as well as self-reported expertise with different visualizations (i.e., how frequently they use/work with line and bar graphs).

This was followed by the calibration of the eye tracker (Tobii X3-120) using a standard 9-point calibration procedure through the iMotions[3] eye-tracking package. Participants then performed two practice tasks (one with a bar graph, one with a line graph). These practice tasks provided participants with an opportunity to learn about the types of tasks, as well as the visualizations themselves. Participants then proceeded to perform a series of 50 tasks (25 with each visualization; total of 20 high information density, 30 low information density). To avoid any learning or ordering effects, all variables were counterbalanced, including visualization type, task question, and density (i.e., the same tasks were not always associated with the same graph). A within-study setup (in terms of all users receiving all visualization types, tasks questions, and density) was chosen to investigate whether

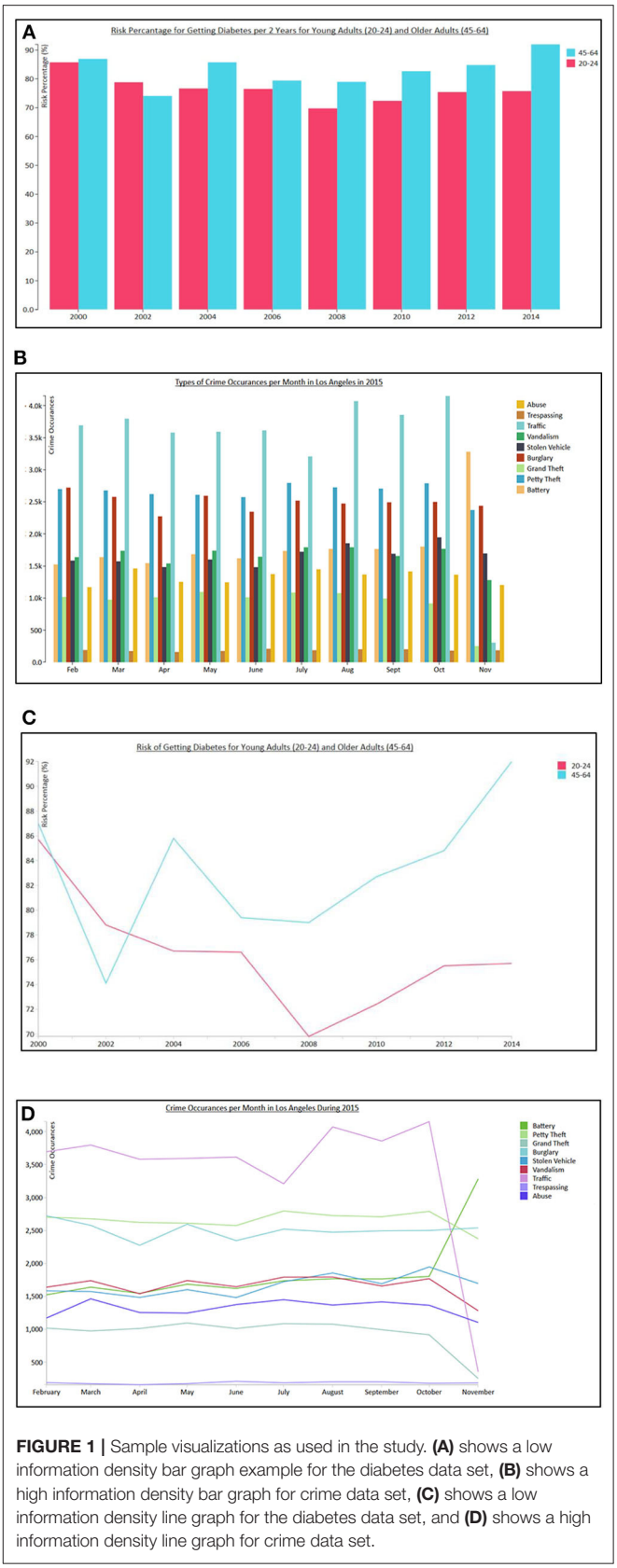

FIGURE 1 | Sample visualizations as used in the study. **(A)** shows a low information density bar graph example for the diabetes data set, **(B)** shows a high information density bar graph for crime data set, **(C)** shows a low information density line graph for the diabetes data set, and **(D)** shows a high information density line graph for crime data set.

[1]https://catalog.data.gov/dataset/diabetes
[2]https://catalog.data.gov/dataset/crime-data-from-2010-to-present-c7a76
[3]https://imotions.com

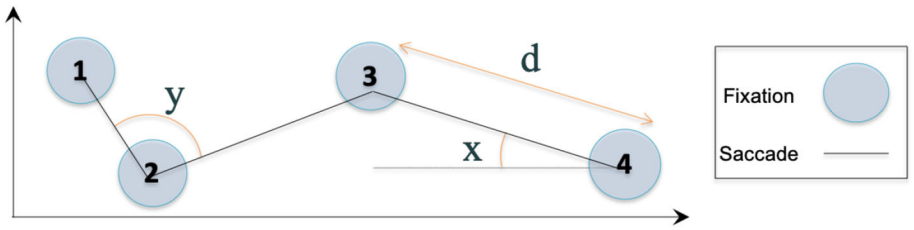

FIGURE 2 | Basic eye gaze data, including fixations, saccades, saccade distance (d), absolute saccade angle (x), and relative saccade angle (y).

a system could infer a user's cognitive style regardless of the visualization or task type, i.e., whether it would be able to infer cognitive style on any given visualization/task combination for a given user.

After all tasks were completed, users performed a test to determine their cognitive style, specifically an online version of the Group Embedded Figures Test (GEFT) (Oltman et al., 1971). This test is a proven and reliable instrument to determine a user's field dependence (FD) (on a scale of 0–18, 0 meaning very field dependent, and 18 meaning very field independent) and has been used in several of the prior works mentioned in the Related Work section (Mawad et al., 2015; Raptis et al., 2016b). Participants were compensated with a $20 gift voucher, and each session lasted ∼1 h on average.

Participant Demographics and Gaze Data

The authors advertised the study through several University mailing lists, with the aim of recruiting a relatively heterogeneous pool of participants in terms of age, fields of expertise, and cognitive style. A total of 40 participants was recruited, with an age range of 18–70 years (mean 28). Among them, 24 participants were female and 16 were male, while the distribution across colleges and departments (e.g., arts, engineering, administration) was relatively balanced. GEFT score evaluations showed a mean of 13.75 (out of 18, SD = 4.24), which suggests that the population was slightly leaning toward field independence (FI). Participants' prior experience with visualizations (as captured through self-rated questionnaires) was also well balanced, with an average of 3.18 out of 5 (SD = 0.93) for simple bar graphs, 2.50 (SD = 1.04) for complex bar graphs, 3.40 (SD = 0.87) for simple line graphs, and 2.80 (SD = 0.88) for complex line graphs.

As with most studies involving eye-tracking equipment, some data-recording issues were encountered with some participants, leaving data from 30 participants to be retained (the majority of the data for the other 10 participants were invalid). This number is in line with similar studies for inferring user characteristics from eye gaze data (e.g., Steichen et al., 2014).

COGNITIVE STYLE INFERENCE EXPERIMENTS

Using the data collected from the above user study, we devised a series of experiments aimed at inferring a user's cognitive style from the user's eye gaze data. Specifically, the raw eye gaze data were first transformed into a series of high-level gaze features, which were then used as input features for classification experiments.

Eye-Tracking Data and High-Level Features

The raw gaze data produced by an eye tracker that consists of simple data points that denote the exact time, duration (in ms), and location (in x–y coordinates) of a user's gaze on a given screen. These precise moments where a user maintains gaze for a specified period of time at a specific point on the screen are referred to as gaze fixations (see **Figure 2**, which was first presented in Steichen et al., 2014).

From these fixations, additional basic data can be extracted, such as the movements/transitions from one fixation to another (referred to as saccades; see **Figure 2**), which have a length (in pixels) and two types of angles (in degrees), namely, a relative angle (i.e., angle between two consecutive saccades) and an absolute angle (i.e., angle between a saccade and the horizontal).

Furthermore, such fixation and saccade data can be analyzed holistically for an entire screen, as well as for particular individual areas of interest (AOIs), i.e., areas that may be of particular interest in terms of analyzing the users' relative attention on different parts of the screen. For our study, particular AOIs were the Graph itself, the Legend, the graph Title, the task Question, the list of task Answers options, as well as the X-axis and Y-axis (**Figure 3**). Using these raw gaze measures and AOIs, we calculated a large set of gaze statistics for each user, including both fixation- and saccade-based features for the whole screen and the different AOIs (**Table 1**). Furthermore, we calculated each of these features on an individual user task basis (i.e., only task 1, only task 2, etc.), as well as on a complete user session basis (i.e., combining all tasks for a user).

Experiment Setup

Using the abovementioned features, we ran a series of classification experiments to investigate the extent to which a user's cognitive style can be inferred based on a user's eye gaze data. In particular, the aim of the experiments was to infer whether a participant was either more inclined toward FD or FI.

A participant's correct FD-I inclination was based on the GEFT scores obtained from the user study. Specifically, we first split participants into two groups using a median split. In addition, we also ran experiments with participants being split using a three-way split (as recommended in Cureton,

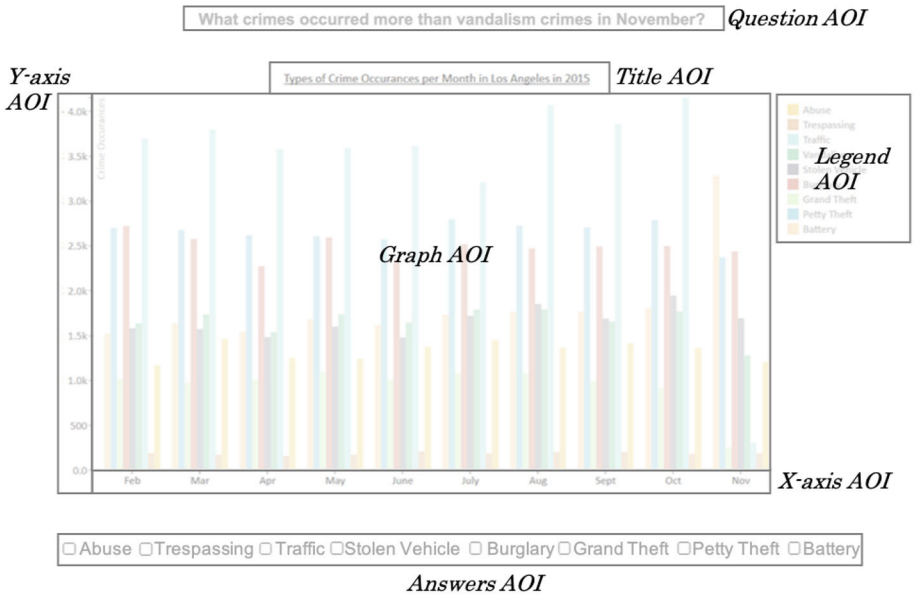

FIGURE 3 | Areas of interest.

TABLE 1 | Features calculated from gaze data.

Whole screen features
Fixations: total number
Fixation durations: sum, mean, standard deviation
Saccade length: sum, mean, standard deviation
Saccade-to-fixation ratio
Relative saccade angles: sum, mean, standard deviation
Absolute saccade angles: sum, mean, standard deviation
Area of Interest (AOI) features (per AOI)
Fixations in AOI: total number
Fixation durations in AOI: Sum, mean, standard deviation
Proportion of total number of fixations in AOI
Proportion of sum of fixation durations in AOI
Longest fixation in AOI

1957). Specifically, the three-way split considered the upper 27% of experiment participants as field independent, the lower 27% as field dependent, and the middle participants as neutral (Cureton, 1957).

In terms of data sets, we ran experiments with each user's complete session interaction (i.e., combined gaze features from all of a user's tasks), as well as individual user tasks (i.e., inferring a user's cognitive style based on a single task interaction).

Furthermore, we ran additional experiments with several subsets of the gaze features, namely, a feature set *without AOI-related features*, a feature set with features that are known to indicate *information searching*, a feature set with features known to indicate *information processing*. Lastly, we also ran separate experiments for *high information density tasks only*, as well as *low information density tasks only*.

For model learning and classification, we used the Waikato Environment for Knowledge Analysis (WEKA) machine learning toolkit (Hall et al., 2009). Specifically, we used the following algorithms: logistic regression, support vector machines, neural networks, as well as the decision tree algorithms J48 (Quinlan, 1993) and RandomForest (Breiman, 2001), using 10-fold cross-validation. The decision for using these algorithms was based on their successful use in prior works using eye gaze data (e.g., Steichen et al., 2014; Conati et al., 2020). While there may be other algorithms that may work even better in our scenario, it should be noted that this work was not meant to be an exhaustive search for the most accurate model, but rather an investigation into the general feasibility of using general purpose machine learning algorithms for cognitive style inference. Likewise, many of these models may be optimized by modifying different configurations. However, for the purposes of the experiments, all default configurations from the WEKA toolkit were used (version 3.8.4). All models were compared to a baseline model (ZeroR), which always predicts the majority class. With the exception of Support Vector Machines, all of the tested algorithms generally performed better than the baseline model. In particular, J48 and RandomForest performed the best throughout the experiments, and therefore, the rest of the analysis will be focused on these two algorithms. As previously mentioned, the default configurations were used for these algorithms without any additional feature selection prior to classification and no specification of maximum depth. The classification output was compared using the standard measure of accuracy. This measure was chosen due to its equal focus on both "positive" and "negative" classifications (i.e., FD vs. FI). Moreover, given that our data sets were reasonably balanced, accuracy represented the most accurate way of gauging the extent to which an adaptive system would receive correct predictions from an inference component. The comparison of

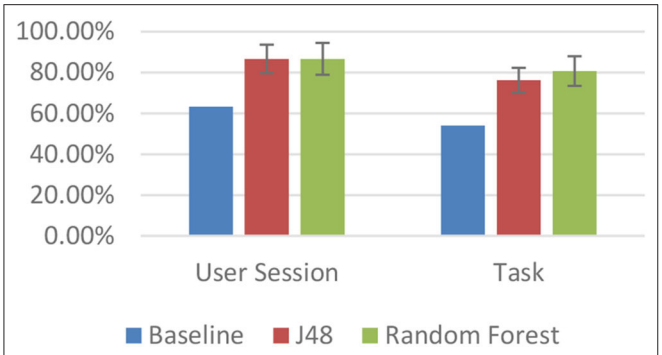

FIGURE 4 | Accuracies for binary field dependence–independence (FD-I) classification using the complete feature set.

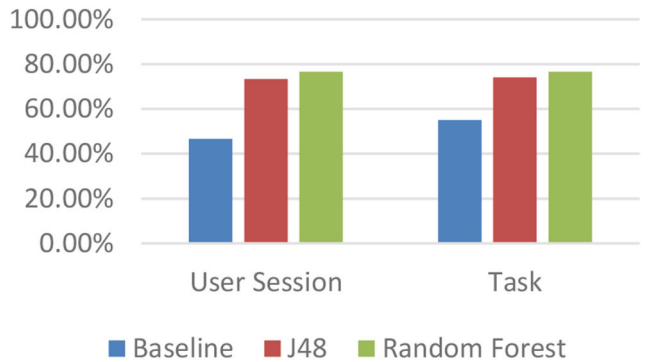

FIGURE 5 | Accuracies for three-way field dependence–independence (FD-I) classification using the complete feature set.

these algorithms with the baseline model was also tested for statistical significance using paired *t*-tests using a significance level of 0.05 (note that WEKA does not output t scores, and therefore, they are not reported, similar to prior work, e.g., Steichen et al., 2014). In order to account for multiple comparisons, we applied Bonferroni correction within each set of classification experiments [e.g., for the user session-based experiment using complete feature sets, the correction accounted for the multiple (3) comparisons involving the baseline, J48, and RandomForest algorithms].

RESULTS

The Classifications Using the Complete Feature Set

As mentioned above, each of the classification results was compared to a baseline that consisted of a majority classifier (ZeroR). This baseline for the *binary FD-I classification* had accuracies of 63.33 and 53.96% for the complete user session and individual task data sets, respectively. As shown in **Figure 4**, when using all of the calculated eye gaze features, several algorithms performed better than this baseline (which was found to be statistically significant, $p < 0.05$), achieving accuracies of up to 86%. In particular, two tree-based algorithms (J48 and RandomForest) always outperformed the baseline classifier with statistical significance. Similar results were found for both data sets, i.e., when using a user's complete session interaction, as well as when using only data from an individual task, although the task-based accuracies were overall a little lower (with a top accuracy of 80%). This slight drop in accuracy is understandable, however, given the significantly lower amount of data available for classification.

When splitting users using a three-way split (i.e., FD, middle, FI), the baseline accuracies were between 46.67 and 55.03%. By contrast, the models learned that using participants' eye gaze data could again achieve significantly better results, with accuracies of up to 76.67% (**Figure 5**).

In addition to these accuracy results, we also analyzed what features contributed the most to these classifications. In particular, when analyzing the decision rules for the decision trees, we found that several features were consistently appearing as some of the most informative. The top three most important features, as observed for many of the machine learning models used, were related to *saccade length*, as well as features related to the *Graph* AOI (**Table 2**). Specifically, a low value for saccade length sum indicated FD, while a high value indicated FI. This may indicate that field-independent participants are able to traverse a graph in greater strides, whereas field-dependent people have smaller saccades overall. Likewise, the standard deviation of saccade lengths was found to be higher for field-independent participants, which indicates that field-independent people have both long and short saccade lengths, while field-dependent people seem to be more restricted in their saccade lengths. Additionally, a low value for the proportion of fixation durations in the Graph AOI (i.e., the duration of fixations that are occurring in the Graph AOI compared to other AOIs) was indicative of field-independent participants, suggesting that less attention is required by such participants to perform tasks. In other words, these results suggest that field-dependent users need to perform longer fixations to understand graph elements, while field-independent users may be able to move more easily around a graph. Since the graph itself elicits the biggest differences between users, our intuition regarding the strong influence of cognitive style on visual element processing appears confirmed. Likewise, the saccade length results may be a direct consequence of this as well, since many saccades may occur inside of the Graph AOI. These results should hold across different types of visualizations (and even if the visualization is smaller, or if there are multiple visualizations); however, this would require additional future experiments to focus specifically on such variations.

No Areas of Interest, Information Searching, and Information Processing Feature Sets

In addition to these classifications using the complete feature set, we also ran several experiments using specific feature subsets.

Firstly, we investigated the extent to which a user's cognitive style could be inferred when using only *features that are not*

related to any AOIs (i.e., only *whole screen features*). The rationale for this feature set was to examine the relative information gain attained from AOI and non-AOI features (particularly since many of the most informative features in the above experiments were not related to AOIs). Additionally, this analysis may provide insights into inferring cognitive style when the inference system does not have any information about which specific visualization a user is currently looking at. In particular, if non-AOI features were shown to be similar to the full feature set, it could be argued that the non-AOI feature set would ease the requirement for the inference system to be fully integrated with the visualization system. This would improve the generalizability of the inference system, which may hence be added as a third-party application rather than a fully connected component.

Results for this *No AOI* feature set showed that classification accuracies did not drop significantly. As shown in **Figure 6**, for each of the different types of classifications (i.e., user-session vs. task-based and binary vs. three-way classifications), the *No AOI* feature set was very comparable to the full feature set. In fact, when running statistical tests (specifically paired *t*-tests, with Bonferroni correction), we did not find any statistically significant differences in accuracies. This finding confirms that it may indeed be sufficient to just observe a user's overall eye gaze data, as opposed to knowing the exact location of the different AOIs of the user's screen. This lies in contrast with previous studies that investigated different user characteristics, such as perceptual speed, or visual and verbal working memory (Steichen et al., 2014), where it was found that the inclusion of AOI features led to significantly higher accuracies. This may suggest that other characteristics are more strongly influenced by a variety of AOIs compared to cognitive style. For example, highly textual AOIs such as the graph title or the legend were previously found to strongly influence verbal working memory experiments. Since the Graph AOI is the most dominant AOI in a visualization task, and given the previous finding that this AOI most strongly elicits differences between users with respect to cognitive style, it appears that the inclusion of fine-grained AOI elements is not necessary in this case. As with the *Complete Feature Set*, we also analyzed the most informative features and again found features related to saccade length to be prominent (**Table 3**). Specifically, a low value for *saccade length sum* again indicated FD, while a high value indicated FI. In addition, this classification showed that a low *fixation duration average* was indicative of *field dependence*, meaning that field-dependent users generally have shorter fixations. Likewise, low *saccade absolute angle standard deviations* were indicative of FD, meaning that field-dependent users have more uniform saccades, whereas field-independent users are more "flexible" in their movements. This is again in line with the results above for the complete feature set findings on saccade lengths.

TABLE 2 | Most informative gaze features for predicting cognitive style (full feature set).

Features	Directionality
Saccade length sum	Lower value -> FD
Saccade length standard deviation	Lower value -> FD
Graph AOI - Proportion of Total Fixation Durations	Lower value -> FI

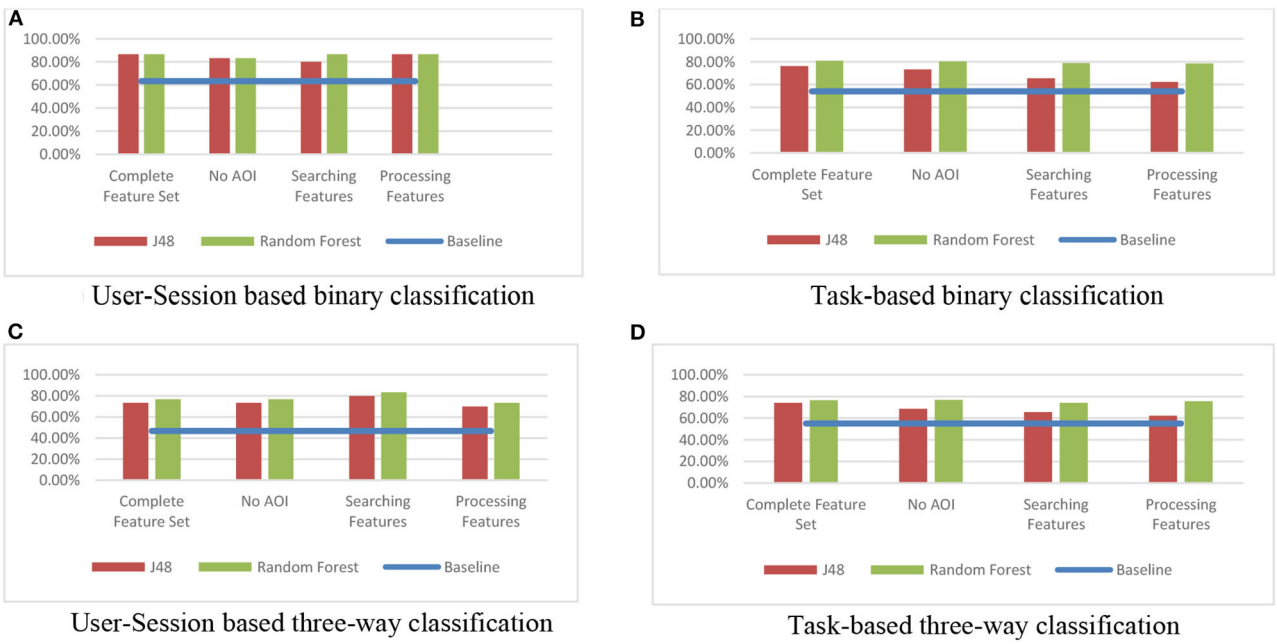

FIGURE 6 | Accuracies for different feature subsets. **(A)** User–Session-based binary classification. **(B)** Task-based binary classification. **(C)** User–Session-based three-way classification. **(D)** Task-based three-way classification.

TABLE 3 | Most informative gaze features for predicting cognitive style (No AOI features).

Features	Directionality
Saccade length standard deviation	Lower value -> FD
Fixation duration average	Lower value -> FD
Saccade absolute angle standard deviation	Lower value -> FD

TABLE 4 | Most informative gaze features for predicting cognitive style (Searching features).

Features	Directionality
Saccade length standard deviation	Lower value -> FD
Saccade length sum	Lower value -> FD
Total number of fixations	Lower value -> FI

TABLE 5 | Most informative gaze features for predicting cognitive style (Processing features).

Features	Directionality
Fixation duration standard deviation	Lower value -> FD
Fixation duration average	Lower value -> FD
Fixation duration sum	Lower value -> FI

In addition to the *No AOI* feature set, we also investigated the extent to which cognitive style could be inferred when using only features that are specifically related to *Information Searching*, as well as only features that are specifically related to *Information Processing*. As suggested in Goldberg and Kotval (1999), a user's *information search* behavior is related to the efficient traversing of a visualization in terms of both the speed of finding visual cues and the number of visual objects that need to be sampled to complete a task. Therefore, *Information Searching* may be conveyed by the *number of fixations and saccades generated*, as well as *saccadic length* features. Similarly, a user's *Information Processing* of a visualization has been linked to the time for a user to understand the given visual information (Goldberg and Kotval, 1999). Thus, if a user spends shorter amounts of time on specific elements, it may be argued that the user had less issues with the visual processing. Likewise, a user's saccade–to–fixation ratio could provide insights into the relative time spent on searching vs. processing. Therefore, the gaze feature set for *Information Processing* included *fixation duration* and *saccade–to–fixation ratio* features only.

As shown in **Figure 6**, both the *Information Searching* and *Information Processing* features fared very well, and in most cases, there was no statistically significant difference in accuracies compared to the *Complete Feature Set* or the full *No AOI* feature set. The fact that both of these feature sets were able to accurately produce inferences suggests that cognitive style significantly influences both a user's information searching and a user's information processing behavior when using information visualization systems. This also confirms the above analysis of important features, since many *Information Searching* and *Information Processing* features were previously shown to be informative for classifications. When specifically analyzing the features used in the *information searching* subset experiments, low *saccade length standard deviations* and *saccade length sums* were again indicative of FD (**Table 4**). In addition, a low *total number of fixations* feature was found to indicate FI, meaning that field-independent users need less fixations to find the information they are looking for. As shown in **Table 5**, *information processing* features related to *fixation durations* such as *standard deviation* and *average* were again indicative of FD, while additionally a low *fixation duration sum* was indicative of FI. This is in line with the results for the *complete feature set*, as well as the *information searching* feature set.

Data Set Split Based on Information Density

Lastly, we performed a series of experiments to evaluate whether inferences would be comparably easy or difficult depending on different information density tasks. To this end, we split our data set according to information density and ran separate classification experiments. Our hypothesis was that the higher information density tasks may be more discriminative, as they may elicit user differences more strongly.

As shown in **Figure 7**, the highest accuracies were indeed achieved when trying to classify users during high information density tasks (specifically using the RandomForest classifier). In fact, the accuracies achieved during this task-based classification were as high as the best user–session-based accuracies reported in Classifications Using the Complete Feature Set section, namely, up to 86%. This is particularly impressive considering that these inferences only used gaze data from a single task. In terms of feature analysis, the most indicative features were again highly similar to the above analyses. The differences were found to be statistically significantly for the three-way classification, but not the binary classification.

Overall, these results confirm our intuition that cognitive style has a greater influence as tasks get more complex, or at least that cognitive style leads users to produce greater differences in eye gaze behaviors for more complex tasks. This suggests that a system that attempts to infer a user's cognitive style should do so during more complex tasks, as this should lead to the best possible prediction accuracy.

SUMMARY AND DISCUSSION

Overall, the results from the gaze-based inference experiments have proven that it is feasible to determine a user's cognitive style with relatively high accuracy while a user is simply engaged in a typical information visualization task. In fact, the accuracies achieved are comparable to prior work (e.g., Raptis et al., 2017), where user tasks had been specifically designed with the purpose of inferring cognitive styles. Moreover, compared to cognitive ability inference experiments (e.g., Steichen et al., 2014), the accuracies found are generally higher, suggesting that cognitive style may have a stronger influence during visualization tasks

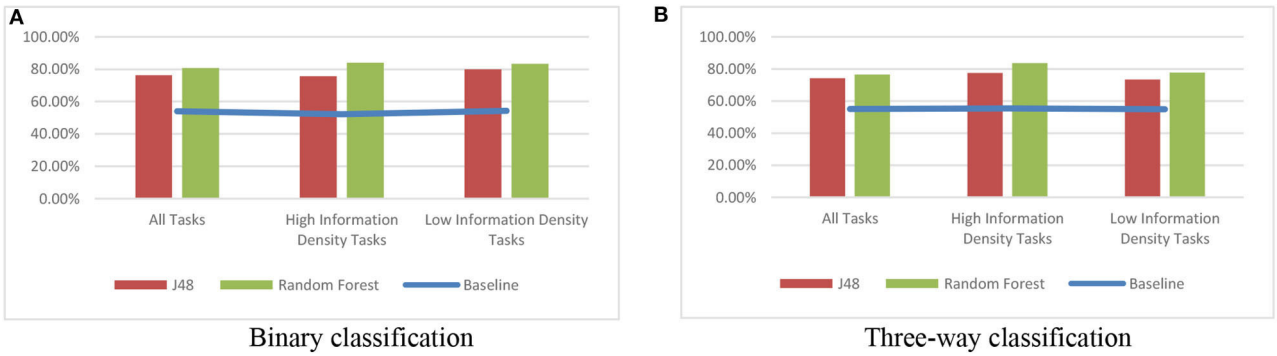

FIGURE 7 | Accuracies for classifications using only high or only low information density tasks. **(A)** Binary classification. **(B)** Three-way classification.

than cognitive abilities, or at least influence eye gaze behavior more strongly.

High accuracies were found across different sets of gaze features, including a *Complete feature set*, a *No AOI* feature set, as well as *Information Searching* and *Information Processing* feature sets. The fact that the *No AOI* feature set performed almost as well as the *Complete feature set* shows that the most important differences between field-dependent and field-independent users can be found at an overall interaction level, rather than within individual AOIs. This result is very encouraging in light of building systems that are added on to information visualization systems, rather than fully integrated systems that need to be fully aware of the exact location of individual graph components.

The more detailed analyses of the classification features revealed that *saccade lengths*, *saccade angles*, and *fixation durations* were the most informative. Specifically, it was found that field-dependent users typically have more "uniform" gaze trajectories (e.g., lower standard deviations of saccade lengths or fixation durations), while field-independent users seem to have greater adaptability. In addition, the fact that most of these informative features are typically associated with both *Information Searching* and *Information Processing* explains why the two additional feature subsets each fared relatively well compared to the *Complete* feature set. This finding also suggests that cognitive style influences both *Information Searching* and *Information Processing* of users when interacting with information visualization systems.

Our findings also suggested that higher information density tasks elicited stronger differences between users, meaning that an adaptive system is more likely to correctly infer a user's cognitive style if the user's task at hand is more complex. Most notably, for high information density tasks, accuracies achieved using task-based classifications (i.e., classifying a user based on only a single task interaction) were even on par with classifications that used a user's full session data. However, knowing the exact task, or at least the complexity/density of the graph, would again require a very tight coupling of the inference system with the actual visualization system, which may not always be practical.

Combined with the findings in Steichen and Fu (2019), namely, that users with different cognitive styles may benefit from different types of overlay aids (e.g., dynamically overlaying data values within a graph, overlaying horizontal/vertical grids, etc.), the overall results from this paper therefore suggest that an integrated adaptive information visualization system may be feasible. In particular, the system would first infer a user's cognitive style using the models presented above, followed by a personalized adaptation of the graph. However, further research needs to be conducted in terms of when and how to deliver such personalized assistance, as well as measuring the actual perceived and objective benefit of such assistance. Specifically, if a system were to provide adaptive personalization without a user's intervention, the disruption caused by the system may be greater than the achieved benefits. Therefore, great care needs to be taken in terms of the adaptive delivery, which may for example take the form of system-driven support to customization, as proposed in Lallé and Conati (2019).

Moreover, while the inference experiments in this work have been largely successful, they have so far been limited to two types of graphs, namely, bar graphs and line graphs, and a pool of 40 participants. Further research needs to be conducted to see whether other visualizations, particularly more complex ones or ones that differ in terms of other visualization modalities, will lead to similar results and whether an increased number of participants may even increase the accuracies achieved. Likewise, future research would be needed to investigate whether other types of user interfaces would also elicit such differences between users. In particular, since it was found that the graph itself elicited the biggest differences, it may be hypothesized that it may not necessarily also be possible to perform inferences with other interfaces. However, given prior research on the influence of cognitive style on many different visual tasks, it may nonetheless be possible to do so, and it is worth studying the extent of this.

Lastly, while this research was conducted using research-grade equipment, such eye-tracking technology has so far not been fully integrated into general-purpose desktop and mobile computers. However, recent outlooks continue to suggest significant growth in the deployment and adoption of eye-tracking equipment (Eye Tracking Global Forecast to 2025, 2020), and lower-cost devices are already starting to be sold either as stand-alone equipment or even integrated into mobile and AR/VR devices.

While it is difficult to estimate the ultimate penetration rate of such equipment, it is conceivable that the production and procurement costs of this technology will reduce sufficiently to allow large-scale deployment within the next decade. In addition, several successful efforts have demonstrated that eye tracking may even be performed using standard cameras (e.g., as found on laptops and phones) (Papoutsaki et al., 2016, 2017), and we are currently in the planning stages for a follow-up study that will investigate the feasibility of our approach using such technology.

CONCLUSIONS AND FUTURE WORK

This paper has presented an initial step toward building information visualization systems that can adaptively support users based on their individual cognitive style. In particular, this paper has shown that it is possible to infer a user's cognitive style using only the user's eye gaze information while performing simple information visualization tasks. Several different feature sets have been shown to provide sufficient informative features to accurately infirm cognitive style, revealing that detailed information on the actual visualization shown (e.g., through detailed AOI information) is not necessary. In addition, it was found that more complex tasks elicited bigger differences in terms of eye gaze behaviors.

Our next steps are to integrate the inference models with adaptation mechanisms in order to study a fully working personalized information visualization system. In particular, Steichen and Fu (2019) had found that different visualization overlays were preferred by users with different cognitive styles, for example, added data values being particularly preferred by field-dependent users, and our inference system could be combined with such overlays to dynamically change the current visualization to best suit individual users. As part of this future work, several different adaptation delivery methods will also be studied, including fully automated, as well as system-driven support to customization mechanisms. In addition, we will conduct further studies to expand on the set of information visualizations beyond simple bar and line graphs, as well as additional adaptation methods beyond the overlays proposed in Steichen and Fu (2019) (e.g., recommending entirely different visualizations). Lastly, we will run additional studies investigating the extent to which the results in this paper may be replicated using standard camera technology, as opposed to research-grade eye trackers.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because of the original IRB application specifications. Requests to access the datasets should be directed to Ben Steichen, bsteichen@cpp.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Cal Poly Pomona Institutional Review Board. The patients/participants provided their written informed consent to participate in this study.

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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Influence of Social Distance Expressed by Driving Support Agent's Utterance on Psychological Acceptability

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In this study, we discuss the psychological acceptability of an utterance strategy used by the *D*riving *S*upport *A*gent (DSA). Previous literature regarding DSA suggests that the adoption of a small robot as a form will increase acceptability. However, the agent's utterance has been reported as a problem faced by the user. Therefore, in this study, we designed the agent's utterance using politeness strategy as described by Brown and Levinson's famous sociolinguistics and pragmatics theory and analyzed its acceptability through a participant-based experiment. In this experiment, we used positive and negative politeness strategies (PPS and NPS, respectively). In general, PPS is utilized to reflect the desire to be liked/recognized by others, whereas NPS is utilized to reflect the need for not wanting to be disturbed by others. Based on our results, PPS was rated high compared to NPS (n = 197). Therefore, many participants highly evaluated PPS. However, there was a group of participants who appreciated NPS. There were also participants who evaluated the two strategies equally. The number of participants in these three groups was observed at 4:1:1. This result contributes as an index on the utterance design of the DSA.

Keywords: human-agent interaction, human-robot interaction, driving support agent, politeness theory, social distance, utterance design, psychological acceptability

INTRODUCTION

Cars are an important method of transportation for many people. However, life-threatening road accidents often occur due to misjudgment/misoperation by the driver. A report published by the World Health Organization (2018) shows that approximately 1.35 million people worldwide have been killed annually due to automobile-related road accidents. Therefore, various researchers are making efforts to reduce the rate of road accidents through various technological inventions. A representative example is the development of automatically driven cars (i.e., level five) in which

the system handles all of the driving operations. If such cars become widespread, it might help to eliminate road accidents due to human errors. However, a country's laws and ethics need to be changed to include fully automatically driven cars, for example, the degree of acceptance of automatically driven cars by the people and taking responsibility in an event of an accident (Hulse et al., 2018; Nunes et al., 2018; Polidori et al., 2018; Meder et al., 2019; Taeihagh and Lim, 2019). Therefore, although the technological progress in the field of automobile engineering is remarkable, it might take more time to popularize fully automatically driven cars among people.

In recent years, with the goal of enabling a new kind of relationship between humans and cars, there is an increasing amount of research on *D*riving *S*upport *A*gent (DSA) (e.g., robot/virtual character) loaded in a car, which acts like a user's partner (Tanaka et al., 2018a,b; Karatas et al., 2019; Lee et al., 2019; Miyamoto et al., 2019). These agents have intelligent utterance functions and support users by voice utterances, hand gestures, and facial gestures. In general, the DSA is intended to assist the user's recognition/judgment (e.g., assist the driver in driving safely by understanding the user's preferences, favorite places, fuel requirement, traffic issues, and so on). Thus, we can say that the DSA is a support aimed at a user who performs his driving operation himself, which is considerably different from an automatically driven car. According to a previous study, small robots that speak a synthesized speech are more acceptable (i.e., not bothersome, not hinder for driving) than that of virtual characters and synthesized speech-only agent (Tanaka et al., 2018a). This information was obtained via a survey questionnaire and gaze behavior analysis. Also, small robots in this context provide assistance only by voice utterances and hand gestures (e.g., pointing left and right). It does not make facial gestures and does not move around on the dashboard. This is because it is dangerous if these actions guide the driver's line of sight. Therefore, in this study, we consider that a small robot that speaks speech is suitable as a form of DSA. In addition, the demand for a DSA in Japan is particularly high. Therefore, in Japan, research and development is in progress with regard to the practical application of DSA (Tanaka et al., 2019).

A DSA that performs voice utterances is considered to be classified as a task-oriented agent. However, the knowledge regarding the utterance design of a task-oriented agent, such as DSA, Siri, and Cortana–in which the user can accept the utterance–has not been established. A study by Luger and Sellen (2016) investigated the previously unknown effects of Siri, Google Now, and Cortana's utterance strategies on the psychology of users. The investigation revealed that there was a problem related to the task-oriented agent's utterance. For example, the user rejects the agent if the agent's utterance content falls far short of the user's expectations (Luger and Sellen, 2016). Therefore, it is important to examine the utterance design of task-oriented agents that support users in their daily lives. Furthermore, studies on DSAs have shown that DSAs improve their receptivity by supporting the user through voice utterances, but there are certain shortcomings. Specifically, Japanese research has shown that users feel annoyed and disgusted with the utterances of DSAs (Fujikake et al., 2017). This problem occurred because Fujikake et al. (2017) had not examined the effect of DSA utterance content on users' psychology (Fujikake et al., 2017). During the DSA–user interaction, if a user feels frustrated due to the behavior of the DSA, then it might affect their driving negatively. Therefore, utterance strategies that enhance the acceptability of DSAs need to be designed.

In studies related to human–agent and human–robot interactions, and topics that deal with artificial media that conduct social interaction with humans, politeness theory (Brown and Levinson, 1987) is seen as an approach to design utterance that is easily accepted by users (Salem et al., 2013; Torrey et al., 2013; Srinivasan and Takayama, 2016; Miyamoto et al., 2017, 2019; Lee et al., 2019). Politeness theory is a well-known framework on conversation in the fields of pragmatics and sociolinguistics. For example, Miyamoto et al. (2017) applied an utterance strategy that increased the parties' closeness, which facilitated the construction of a smooth relationship with the other party. In particular, agent utterances were designed based on negative politeness and positive politeness strategies (NPS and PPS, respectively). The effects of PPS and NPS were compared by participant experiments. Herein, NPS is an utterance strategy that maintains closeness with a conversation partner by apologizing, using fuzzy opinion, and so on to reflect the partner's need for not wanting to be disturbed, whereas PPS is an utterance strategy that increases closeness with a conversation partner by compliments, includes a partner in action, and so on to reflect the partner's desire to be liked/recognized (Brown and Levinson, 1987). In Miyamoto et al.'s study (2017), PPS is an utterance strategy that increases closeness with another party through joking behavior. Miyamoto et al. (2017) assume non-task-oriented conversation scenes for Japanese between human and agent. However, the general DSA behaves for a task as driving a car. In English and Korean language studies, the efforts to use PPS and NPS for task-oriented utterance design such as robots are attracting greater attention (Salem et al., 2013; Torrey et al., 2013; Srinivasan and Takayama, 2016; Lee et al., 2019).

Lee et al. (2019) designed a DSA's utterance using politeness and verified the effect by conducting an experiment with a participant. According to their results, the implementation of polite utterance using NPS was found to be satisfactory. Therefore, their result suggests that it is important to consider social factors in an utterance design of a DSA. However, in their study, 26 out of 56 participants did not have a driver's license. Therefore, 46.4% of the participants in Lee et al.'s study have never driven a car. In their study, the agent does not have a physical form. It has been reported that people are significantly more receptive of small robots than agents without physicality (Tanaka et al., 2018a). On the other hand, Miyamoto et al. (2019) conducted an utterance design of a small robot as the DSA based on the politeness strategy; however, their participants were limited to students. The video used in the experiment as stimulus presentation to experimental participants observes the interaction between a user and an agent from a third-party perspective, which

means it has not been evaluated from the driver's perspective. These previous studies provided useful knowledge into the design of DSA utterances, but the experiment has its drawbacks. Additionally, Lee et al. (2019) and Miyamoto et al. (2019) reported different findings. Lee et al. (2019) showed that NPS was accepted by users, while Miyamoto et al. (2019) reported that PPS was more acceptable to users than NPS. Furthermore, neither study verified the validity of DSA utterances in terms of politeness theory. Therefore, the acceptability of NPS/PPS in the design of DSA utterance is questionable.

In this study, we aimed to examine the relationship between the psychological acceptability of a DSA and the social factors that are expressed by an agent's utterance (i.e., PPS vs. NPS). In our experiments, we resolve certain issues that had not been adequately addressed in previous studies (Lee et al., 2019; Miyamoto et al., 2019). Specifically, the emphasis will be on obtaining data on the acceptance of DSA by experimental participants with a driver's license. So, the video was created as a stimulus presentation for the experimental participants listening the agent utterances from the driver's perspective. The reason for using videos for experiments is to get as much experimental data as possible. The validity of the utterance is confirmed by a discussion between politeness theory specialist researchers. This study implements a DSA utterance that expresses social factors using a politeness strategy. We focus on social distance from among the social factors in this study. Specifically, PPS was implemented as a situation in which the DSA estimated that the social distance to the user was short, and NPS was implemented as a situation in which the DSA estimated that the social distance to the user was long. Then, we compared the acceptability of DSA utterances. This gives us knowledge that contributes to the utterance design of agents acting as user partners. The new findings that this study provides for the design of DSAs are as follows. We believe that these findings are more robust than previous studies in terms of the number/quality of participants and the validity of the politeness utterances in the experiment.

- The ratio of users who prefer PPS, users who prefer NPS, and users who evaluate the two strategies equally is 4:1:1.
- PPS significantly increases the anthropomorphism and animacy of the DSA compared to NPS.
- There is a strong positive correlation between the user's perceived intelligence of the DSA and driving support acceptance evaluations of the DSA.

Also, in this study, we used Japanese language in the utterance design of the agent because of the growing need for DSA in Japan (Tanaka et al., 2019). However, future studies can be targeted with users with different cultural backgrounds and with other languages.

This study is presented as follows. Chapter 2 gives an overview of the politeness strategy (Brown and Levinson, 1987) and its application in this study. In Chapter 3, we explain how to design DSA's utterances and how to create videos for the evaluation. In Chapter 4, an experiment is performed using the created video. In Chapter 5, we show the experimental results. Chapter 6 discusses the experimental results, and finally, Chapter 7 presents the conclusion.

POLITENESS THEORY

Brown and Levinson's Politeness Strategies

Of the two individuals interacting with one another, we define the speaker as *S* and the listener as *H*, based on the work of Brown and Levinson (1987). According to Brown and Levinson (1987), both *S* and *H* desire to form an interpersonal relationship with one another. This desire is called "face" (Goffman, 1967) and is classified as either a negative face or a positive face. A negative face is the desire to separate and be independent from others, whereas a positive face is the desire to be favored by others. In general, *S* wishes to preserve *H*'s face during dialogue. However, depending on the action, the result may threaten *H*'s face. Such an action is called a face-threatening act (FTA). When *S* needs to perform an FTA toward *H*, *S* estimates the weight of the FTA. Here, the weight of the FTA is calculated as per the following equation (Brown and Levinson, 1987).

$$Wx = D(S, H) + P(H, S) + Rx \quad (1)$$

In Eq. 1, D is a value that indicates the social distance between *S* and *H*, P is the amount of force *H* exerts on *S*, and Rx is a value that indicates how burdensome the FTA is perceived to be within the two parties' specific cultural context. More specifically, the weight (Wx) of the FTA is the sum of D, P, and Rx. Since P and Rx fluctuate across cultures, the weight of the FTA also varies depending on the given culture, even if utterance is identical. *S* chooses a politeness strategy according to Wx. The most representative politeness strategies are PPS and NPS. PPS is selected by *S* when Wx is relatively low (i.e., *H* has a positive face). Conversely, if Wx is high (i.e., *H* has a negative face), *S* chooses NPS. **Table 1** shows all 10 strategies for NPS and 15 strategies for PPS. *S* uses these strategies in conversation to build good relationships with the *H*.

Interpretation of Politeness Strategies

In this study, we focus on D from among the social factors. The politeness strategies also affect social factors other than D (i.e., P and Rx). However, P is fixed in the interaction between the user and the DSA in this study. Specifically, since the DSA is a tool that supports users, it has a smaller P than users. Also, Rx does not change in this study because it restricted to the Japanese context. Therefore, in this study, P and Rx are fixed in the relationship between users and the DSA, and the DSA changes representation of D (estimate) through PPS/NPS.

According to the section "Brown and Levinson's Politeness Strategies," the politeness strategy (Brown and Levinson, 1987) plays an important role in the smooth communication between

TABLE 1 | Politeness strategies (Brown and Levinson, 1987).

PPS	NPS
1: Notice, attend to *H* (his interests, wants, needs, goods)	1: Be conventionally indirect
2: Exaggerate (interest, approval, sympathy with *H*)	2: Question, hedge
3: Intensify interest to *H*	3: Be pessimistic
4: Use in-group identity markers	4: Minimize the imposition, *Rx*
5: Seek agreement	5: Give deference
6: Avoid disagreement	6: Apologize
7: Presuppose/raise/assert common ground	7: Impersonalize *S* and *H*: Avoid the pronouns "I" and "you"
8: Joke	8: State the FTA as a general rule
9: Assert or presuppose *S*'s knowledge of and concern for *H*'s wants	9: Nominalize
10: Offer, promise	10: Go on record as incurring a debt, or as not indebting *H*
11: Be optimistic	
12: Include both *S* and *H* in the activity	
13: Give (or ask for) reason	
14: Assume or assert reciprocity	
15: Give gifts to *H* (goods, sympathy, understanding cooperation)	

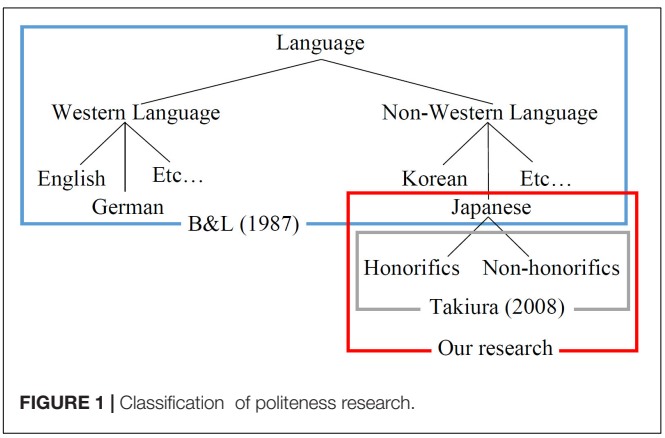

FIGURE 1 | Classification of politeness research.

two parties. According to Usami (2002) and Kiyama et al. (2012), politeness theory can also be applied to non-Western cultures. However, the primary subject of politeness theory is the language of Western culture. Therefore, we will discuss how to handle PPS/NPS according to a target language. By considering how to handle politeness strategies according to the language used by agents, discussions can be made according to culture.

Figure 1 shows the classification of politeness research in Western language/non-Western language. The politeness theory (Brown and Levinson, 1987) also covers non-Western language, but an effect of Japanese honorifics on a face is not described in detail. According to Takiura (2008), honorifics in Japanese generally represents a remoteness of *D*, similar to NPS, and non-honorifics generally represent the closeness of *D*, similar to PPS. Therefore, honorifics/non-honorifics is important to express *D* by using Japanese. Therefore, in this study, in addition to PPS/NPS defined by Brown and Levinson (1987), Japanese sentence ending expressions (honorifics/non-honorifics) are included in the politeness strategy. Furthermore, in this study, in order to clarify the difference in *D* expressed by PPS and NPS, end of sentence of the agent's utterance that used NPS is designed honorifics, and end of sentence of the agent's utterance that used PPS is designed non-honorifics.

Based on Brown and Levinson (1987), we discuss the effect of PPS and NPS on the *D* between *S* and *H*. Here, the closeness (*C*) between *S* and H is defined as follows.

$$C = -D \tag{2}$$

In other words, the smaller the *D* between *S* and *H*, the higher the intimacy between *S* and *H*. *C* is expected to change over time. For example, from the time when *S* and *H* first meet ($t = 0$), *S* influences *H*'s face through politeness strategy (PPS/NPS), and *C* changes immediately after that ($t = 1$). However, here, following Brown and Levinson (1987), the change in *C* in one utterance unit is the subject of discussion. In other words, this paper does not consider the integral value of *C* in a long-term conversation. Based on the above, we define the closeness (C_t) between *S* and *H* at a certain time (t) as follows.

$$C_t = F_{t-1} - T_{u,\,t-1} \tag{3}$$

In Eq. 3, *F* is the degree to which *H*'s face is satisfied, and T_u is the degree to which *H*'s face is threatened by *S*'s utterance (u: *PPS*, *NPS*). According to Brown and Levinson (1987), *H*'s face is threatened to some extent by PPS/NPS by *S*, so T_u is positive ($T_u > 0$). If *S* chooses a politeness strategy (PPS or NPS) with a small $T_{u,t-1}$, C_t will be relatively high since the violation of *H*'s face can be minimized. In this case, if $C_t \geq 0$, then *H* is considered to be in a comfortable state at *t*. In other words, the relationship between the value of C_t and the state of *H* is as follows.

- $C_t \geq 0 \leftrightarrow H$ feels Comfort at t ($\leftrightarrow$: Necessary and sufficient conditions)
- $C_t < 0 \leftrightarrow H$ feels Discomfort at t

The type of face that *H* has (positive face/negative face) varies according to the relationship between the value of C_t and the threshold of the face (θ_F) (Brown and Levinson, 1987). In this case, the value of $T_{u,t}$ varies as follows.

- $C_t > \theta_F$ (i.e., *H* has Positive Face) $\leftrightarrow T_{PPS,t} < T_{NPS,t}$
- $C_t < \theta_F$ (i.e., *H* has Negative Face) $\leftrightarrow T_{PPS,t} > T_{NPS,t}$

In other words, the effect of PPS/NPS changes depending on the type of face that *H* has. In this paper, in order to investigate the psychological effects of PPS and NPS by DSA on users, we set up a condition in which *C* between DSA and users is estimated to be high (PPS condition) by DSA and a condition in which *C* is estimated to be low (NPS condition) by DSA in a within-subjects design.

MATERIALS AND METHODS

In this study, the utterance of the DSA is designed based on PPS/NPS, and the psychological acceptability is verified. In particular, emphasis is placed on obtaining evaluation data from many participants; therefore, we used videos to evaluate. In the following, utterances and videos of DSA used for evaluation are described.

Driving Situations

There are various situations that a driver encounters while driving a car. However, it is considered that evaluating an acceptability of the agent's utterances for all the possible driving situations would increase the cost of experiments. We also consider that agents should not speak in situations where the driver is driving at a very high cost. Even in the preliminary survey, in the actual vehicle environment, the situation and frequency of utterances by the driving support agent are strongly restricted (Tanaka et al., 2020). The most important task for a driving support agent is to encourage the driver to drive safely, but in a high-cost situation where it is difficult to accept comments from others even if the agent makes full use of the politeness strategy, there is a risk of its adverse effects on driving. Therefore, in this study, the driving situations to be evaluated in the experiment are limited in order to reduce the cost (restraint time, fatigue, etc.) of the experimental participants. Specifically, in this experiment, it is assumed that experimental participants drive the experimental course used in Tanaka et al. (2018a). **Figure 2** shows the simulated driving course used by Tanaka et al. (2018a). This course is a reproduction of the road around Nagoya University in Japan. In this study, we designed and evaluated agent utterances for a parked car avoidance, intersection with a stop sign (go straight/turn right/left), a pedestrian avoidance, and a left curve. In each driving situation, the agent speaks once.

Utterance Strategies to Be Evaluated

As described in the section "Politeness Theory," politeness strategies are effective in manipulating *D* in interpersonal relationships, and *D* expressed by speech affects closeness (Brown and Levinson, 1987). **Figure 3** illustrates the relationship between politeness strategies and closeness in this study. It indicates that the closer the *D*, the lower is the degree of face infringement assumed by *S* and the higher is the closeness expressed by *S*'s utterance. PPS shrinks the *D* between *S* and *H* if it is used when *H* has a positive face, and NPS maintains the *D* between *S* and *H* by minimizing the violation of *H*'s face if it is used when *H* has a negative face (Brown and Levinson, 1987). Therefore, PPS has a higher degree of closeness with *H* assumed by *S* and a higher degree of closeness when the utterance is accepted by *H* than NPS. Also, there are direct utterances that do not use politeness strategy (e.g., "*Slow down!*"). However, direct utterances have been reported to be less acceptable in driving support (Fujikake et al., 2017; Tanaka et al., 2018a) and significantly less acceptable than PPS/NPS (Salem et al., 2013; Torrey et al., 2013; Srinivasan and Takayama, 2016; Deshmukh et al., 2018; Lee et al., 2019). Previous studies have shown that direct speech is less receptive than PPS/NPS. Therefore, in this paper, direct utterance is not adopted as an experimental condition, and NPS condition and PPS condition are set as experimental conditions.

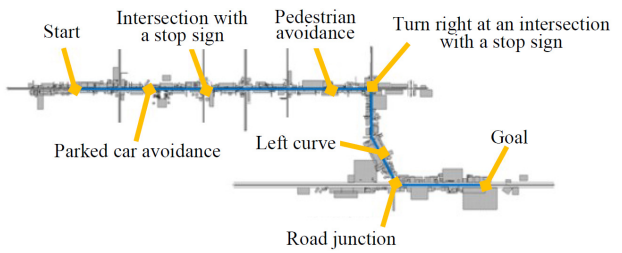

FIGURE 2 | Experimental course (Tanaka et al., 2018a).

Utterance Design

Herein, we designed an utterance of a DSA. First, as described in the section "Driving Situations," an agent speaks for a parked car avoidance, intersection with a stop sign (go straight/turn right/left), a pedestrian avoidance, and a left curve. Of these, at an intersection with a stop sign, go straight/turn right/left are regarded as one category (i.e., driving situation). Next, utterances are created for strategies that are considered to be applicable to the driving situation that occurs in the course presented in **Figure 2**. The support provided by the agent is suggestions and instructions for correcting a user's driving behavior. This was determined with reference to Tanaka et al. (2018a). For example, on the left curve in **Figure 2**, a deceleration instruction is given to encourage safe driving. **Table 2** shows the PPS targeted in this study. All 10 NPSs were covered in this study. In addition, eight PPS strategies were considered: "Exaggerate (interest, approval, sympathy with *H*)," "Seek agreement," "Presuppose/raise/assert common ground," "Assert or presuppose *S*'s knowledge of and concern for *H*'s wants," "Offer, promise," "Be optimistic," "Include both *S* and *H* in the activity," and "Give (or ask for) reason." We excluded the other seven strategies for the following reasons: Mainly used in non-task-oriented dialogue (i.e., "Notice, attend to *H* (his interests, wants, needs, goods)," "Intensify interest to *H*," "Joke," and "Use in-group identity markers"); for offering support itself (i.e., "Assume or assert reciprocity" and "Give gifts to *H* (goods, sympathy, understanding cooperation)"); and for responding to the other's utterance (i.e., "Avoid disagreement"). Based on this, by using all NPS strategies and eight PPS strategies, a total of 72 utterances were created for four types of driving situations: a parked car avoidance, intersection with a stop sign, a pedestrian avoidance, and a left curve.

As described in the section "Interpretation of Politeness Strategies," we designed the utterances based on Takiura (2008). We placed emphasis on the distant aspect of *D* by using NPS utterances as honorifics. In addition, the utterances using PPS were made non-honorific and emphasized a close aspect of *D*. However, we need to examine the validity of politeness strategies included in utterances. In this regard, we request two Japanese researchers specializing in politeness theory to evaluate the validity of the utterances.

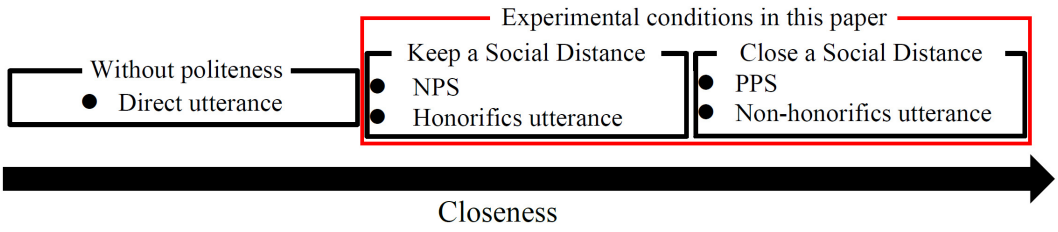

FIGURE 3 | The relationship between politeness strategy and closeness in this study.

Both experts will evaluate the 72 utterances we created in three stages as follows: "no problem," "substantially no problem," and "problem" from the perspective of "whether it is correct as a politeness strategy." The utterances were modified as necessary by politeness researchers. Based on the results of evaluation and discussions with politeness researchers, PPS and NPS were adopted for each five utterances so that the number of strategies was as many as possible. These utterances were selected from the 15 utterances that were rated "no problem" or "substantially no problem" by both politeness researchers. Five utterances were excluded to avoid overlapping politeness strategies as much as possible in the evaluation. It is important to suppress the influence on psychological acceptability caused by factors other than *D*. Specifically, three strategies of NPS (i.e., "Question, hedge," "Minimize the imposition, *Rx*," and "Apologize") and two strategies of PPS [i.e., "Include both *S* and *H* in the activity" and "Give (or ask for) reason"] were adopted.

Creating the Experimental Videos

In this study, we created a video from a user's perspective so that participants can feel as real as possible. The driving scene uses the video recorded in Tanaka et al. (2018a). This video was recorded by the drive recorder when the driving school's instructor was driving the same course as presented in **Figure 2**. The video of the drive recorder was provided to us by Tanaka et al. We created a video of the DSA speaking and composited it with the video of the drive recorder. Aviutl[1], a video editing software, was used for this work. We referred to Tanaka et al. (2018b) for the installation position and direction of the agent. RoBoHoN (SHARP) was used as the agent. **Figure 4** shows the appearance of RoBoHoN, which is a small robot with a height of about 19.5 cm that can speak with the synthesized speech and has been used as a DSA by previous research (Tanaka et al., 2018b; Miyamoto et al., 2019). The voice of the RoBoHoN was constructed as per the following parameters: "5-year-old boy, innocent, cheerful, and diligent character" (SHARP).

We created a video that the agent speaks using NPS and a video that utters using PPS. The agent's utterance assumes that a user is driving the course, as shown in **Figure 2**. **Figure 5** shows the created video image. **Figures 5A–F** correspond to the situation that occurs in the driving course shown in **Figure 2** and play in this order. The utterance contents shown in **Figure 5** are accompanied by the name of a politeness strategy used. The playback time of each video is about 2 min. The only difference between the two videos is the utterance content of the agent. The videos are shown as a **Supplementary Video 1**.

TABLE 2 | In the case of PPS, the strategies evaluated by politeness theory specialist researchers and the strategies pre-excluded by the authors in the section "Utterances Design" were considered.

	Strategies	Reason of pre-excluded
Strategies evaluated by experts	2: Exaggerate (interest, approval, sympathy with *H*)	
	5: Seek agreement	
	7: Presuppose/raise/assert common ground	
	9: Assert or presuppose *S*'s knowledge of and concern for *H*'s wants	
	10: Offer, promise	
	11: Be optimistic	
	12: Include both *S* and *H* in the activity	
	13: Give (or ask for) reason	
Strategies pre-excluded by the authors	1: Notice, attend to *H* (his interests, wants, needs, goods)	Used in non-task-oriented conversations.
	3: Intensify interest to *H*	
	4: Use in-group identity markers	
	8: Joke	
	14: Assume or assert reciprocity	Used to offer support etc. itself.
	15: Give gifts to *H* (goods, sympathy, understanding cooperation)	
	6: Avoid disagreement	Used to reply to the other person's utterance.

The NPS had experts evaluate all strategies. As a result of the evaluation by experts, 2 strategies of PPS and 3 strategies of NPS were adopted as experimental stimuli.

[1]http://spring-fragrance.mints.ne.jp/aviutl/ (accessed 2019.12.10).

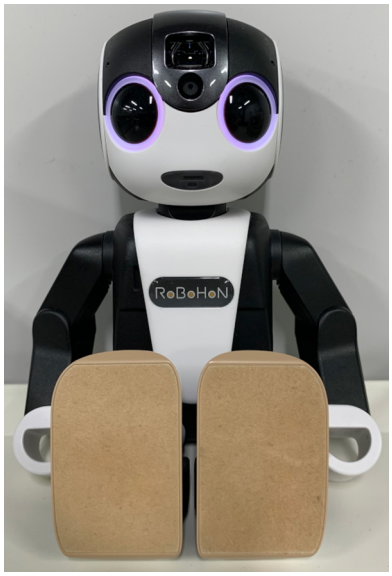

FIGURE 4 | RoBoHoN (SHARP).

EXPERIMENT

The purpose of this experiment is to verify the influence of social distance expressed by DSA's utterance on psychological acceptability (i.e., PPS vs. NPS). To collect as many samples as possible, participants were recruited by crowdsourcing and an experiment was conducted in which participants watched the videos we created in the section "Utterances Design" (i.e., within-subjects design). The participants viewed the videos and answered the questionnaires on Google Forms[2]. The order of the videos to be viewed was counterbalanced by considering the order effect. The experiment was conducted based on the Research Ethics Guidelines for Humans of the Society of Automotive Engineers of Japan[3].

Procedure

First, a briefing is performed by presenting a text about the flow of the experiment to the experimental participants. Next, the text "This robot will support your driving by voice" is presented along with RoBoHoN images as an explanation of the robot used in this experiment. Furthermore, **Figure 5A** (without utterance text) was presented to the participants as an explanation of the position and orientation of RoBoHoN in the videos. In addition, we presented the following text to the participants: "The robot is in the car and sits in a place near the lower left of your front. Also, the robot sits facing forward as shown in the image below to check the surrounding situation. The same is true for the next video." and "Please watch the video as if you were driving." After that, the participants watch the videos that the agent speaks by using only NPS and using only PPS. Labels (A,B) are attached to the two videos. Participants in the experiment watched videos A and B in that order. To offset the order effect of the PPS condition and the NPS condition, the experimental participants were randomly divided into a group with the PPS condition as video A and a group with the NPS condition as video A. At the end of the experiment, the participants answered the agent evaluation questionnaire. At this time, the participants were instructed to compare and evaluate the impressions of the agents in videos A and B. Also, the participants in the experiment were instructed to answer the questionnaire in an intuitive manner. As the last question of the questionnaire, the participants will answer the following questions with two choices: Yes/No "The agent's wording were different at the two videos. Did you notice about it?" The experiment ends when the participants answer all the questions in the questionnaire.

[2]https://www.google.com/intl/ja_jp/forms/about/ (accessed 2019.12.10).

[3]Society of Automotive Engineers of Japan, https://www.jsae.or.jp/01info/rules/kenkyu-rinri.html (accessed 2019.12.10).

Evaluation Items

Acceptability Evaluation of Driving Support

In this experiment, we used the questionnaire by Tanaka et al. (2018b) and adopted the seven-point Likert response scale system (1: *Perfectly not agree*; 2: *Hardly agree*; 3: *Pretty much not agree*; 4: *Neither*; 5: *Pretty much agree*; 6: *Almost agree*; and 7: *Perfectly agree*) to obtain responses. The following nine items were evaluated:

Q1: Favorability
Q2: Reliability
Q3: Familiarity
Q4: Want to use
Q5: Usability
Q6: Contribution for safe driving
#Q7: Uncomfortable
#Q8: Annoyance
#Q9: Disturbance

Of these, Q7, Q8, and Q9 with "#" are inverse items. For example, in Q7, as the evaluation value approaches seven, the numbers are reversed so that the evaluation is "Not uncomfortable."

Impressions Based on General Evaluation Items for Social Robots

The Godspeed questionnaire developed by Bartneck et al. (2009) can investigate general anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety as evaluation items for robot. In this study, we focused on anthropomorphism, animacy, and perceived intelligence. We consider that these are difficult to evaluate on the questionnaire shown in the section "Acceptability Evaluation of Driving Support." The participants respond on the five-point Semantic Differential method for items that evaluate each factor (Bartneck et al., 2009).

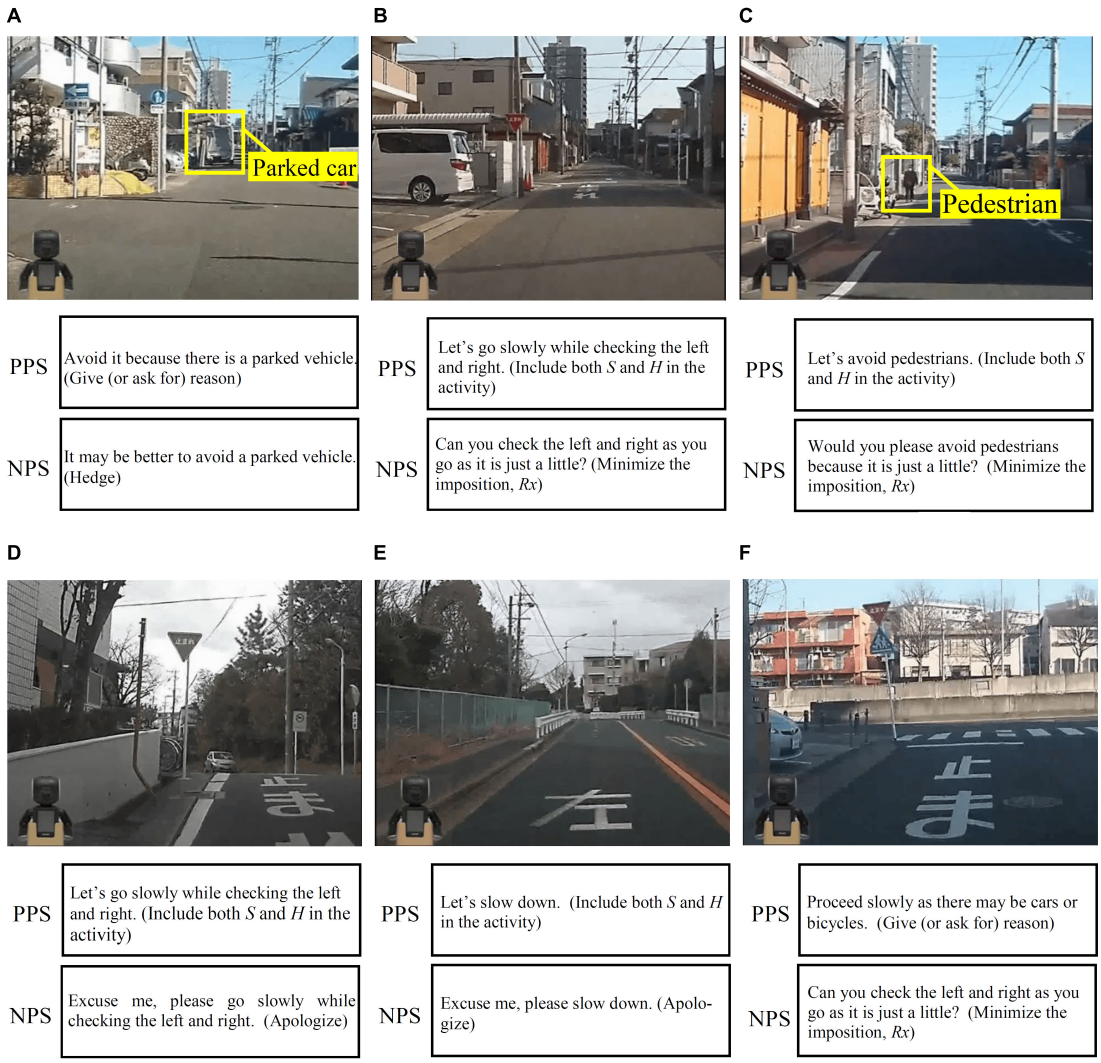

FIGURE 5 | Experimental videos and utterances (strategy). **(A)** is "Parked car avoidance;" **(B)** is "Intersection with a stop sign;" **(C)** is "Pedestrian avoidance;" **(D)** is "Turn right at an intersection with a stop sign;" **(E)** is "Left curve;" and **(F)** is "Road junction."

Participants

The 222 users of Crowd Works[4], a famous crowdsourcing service in Japan, participated in this experiment. One problem in experiments using crowdsourcing is the possibility that the crowdsourcer may do a lax job (Burmania et al., 2015; Jonell et al., 2020). In this experiment, we used the results of responses to the question "The agent's wording was different at the two videos. Did you notice about it?" which was used as an indicator to check whether the participants watched the videos. In each experimental condition, the sentence ending styles are different, which is perceived as a clear difference by Japanese speakers. Therefore, we assumed that the participants who did not notice the difference in wording did not watch the videos carefully. Thus, a total of 24 participants were excluded who responded that they did not notice the difference in the wording of the agent from the participants. Also, one participant whose responses were incomplete was excluded. In other words, 197 people [male: 103, female: 94, average age = 38.2 years, standard deviation (*SD*) = 9.6] are the subjects of analysis in this experiment. The participants in this experiment had a valid car driving license. After the experiment, participants received an incentive (i.e., 300 yen).

[4]Crowd works, https://crowdworks.jp/ (accessed 2019.12.10).

RESULTS

Manipulation Check

Based on the score of "Unfriendly-Friendly" items in the Godspeed questionnaire (i.e., one is unfriendly; five is friendly), PPS [Mean (*M*) = 3.5, standard error (*SE*) = 0.07] gave a friendlier impression to the participants than that of the NPS (*M* = 2.6, *SE* = 0.07). As a result of Wilcoxon's signed-rank

test, significant differences were found ($p < 0.001$, effect size (r) = 0.49). In addition, the "Familiarity" rating was higher for PPS (M = 4.6, SE = 0.1) than that of NPS (M = 3.5, SE = 0.1) on the scale for driving support acceptance in the section "Acceptability Evaluation of Driving Support." There was also a significant difference in this item ($p < 0.001$, r = 0.53). These results suggested that PPS was rated higher than NPS in the assessment items related to closeness. Therefore, the relationship between D expressed by the DSA (i.e., the expected effect of PPS/NPS in the experimental condition) and the evaluation of D by the experimental participants (mean value) is consistent with **Figure 3**.

Result 1: Acceptability as the Driving Support

Herein, in order to analyze the relationship between utterance strategy and acceptability, the data collected in the section "Experiment" were classified into the following four groups: all participants (i.e., *All participants*, n = 197), the participants who appreciated PPS (i.e., *PPS group*, n = 134, male: 64, female: 70, average age = 38.9 years, SD = 9.4), the participants who appreciated NPS (i.e., *NPS group*, n = 32, male: 19, female: 13, average age = 35.6 years, SD = 8.1), and the participants who evaluated PPS and NPS equally (i.e., *Even group*, n = 31, male: 20, female: 11, average age = 37.7 years, SD = 11.6). The classification of the participant groups is based on the comparison of the results of the total score (minimum score is 9 and maximum score is 63) between PPS and NPS of each of the participant in all the nine items (*Cronbach's alpha* = 0.94). The items used in the manipulation check ("Familiarity") were also included in this analysis. We compared the total PPS scores of nine items (*Spps of Pi*) and total NPS scores (*Snps of Pi*) as assessed by a certain participant (*Pi, i*: 1–197) and grouped them according to the following procedure.

If (Spps of Pi > Snps of Pi)

Pi is in the PPS group

else If (Spps of Pi < Snps of Pi)

Pi is in the NPS group

else

Pi is in the Even group

We adopted this procedure to classify all the participants (n = 197) in order to ensure that all of them were included in the analysis. The ratio of the number of participants in each group was approximately 4:1:1. To examine the validity of these groups, an ordinal logistic regression analysis was conducted with the group to which each participant is assigned (PPS group, NPS group, and Even group) as the objective variable. The explanatory variables in this analysis were the ratings value for each of the nine items by participants in each experimental condition. As a result of the analysis, a significant model was obtained ($p < 0.001$). The coefficient of determination (Nagelkerke) of the model was 0.51, and the prediction accuracy of the objective variable was 72.08% (chance level is 33.3%). Based on these results, we believe that the group classification of the participants in this experiment is generally appropriate.

Figure 6 shows the evaluation of the results of all items by *All participants*. In the figure, the higher the value on the vertical axis, the higher the acceptability of the utterance strategy. The Wilcoxon signed-rank test was performed to investigate whether there is a statistical difference in each item. As a result of the test, it was found that the evaluation of PPS was significantly high in all 9 items (i.e., $ps < 0.001$). It can be seen that *All participants* highly appreciated PPS. These p-values are corrected by the Bonferroni multiple-comparison correction method. In addition, r of each item is shown in **Figure 6**. Medium to large effect sizes ($0.34 \leq r \leq 0.53$) were obtained for all items. This suggests that the PPS is more acceptable than the NPS to many users. **Figure 7** shows the evaluation results for each group. The vertical axis of this graph is the mean value of the total score of PPS and NPS for all 9 items. The mean of PPS is 6.8 points higher than the NPS in the *All participants*. The statistical analysis of PPS and NPS scores revealed a significant difference based on the Wilcoxon signed-rank test in *All participants* (i.e., $p < 0.001$, r = 0.57). Thus, a large effect size was obtained even when comparing PPS and NPS ratings in terms of the total score of the nine items.

Result 2: Godspeed Questionnaire

Based on the *All participants/PPS/NPS/Even group* classified in the section "Result 1: Acceptability as the Driving Support," the results of the Godspeed scale are analyzed. In other words, we investigate the relationship between driving support acceptance and anthropomorphism/animacy/intelligence. When performing a significant difference test in this section, the p-value is corrected using the Bonferroni multiple-comparison correction method in consideration of the multiple comparisons for the four data groups. **Figure 8** shows the evaluation results of anthropomorphism. The mean of the PPS is higher than that of the NPS in the *All participants*. The Wilcoxon signed-rank test showed significant differences in the *All participants* (i.e., $p < 0.001$, r = 0.50, stochastically significant after the Bonferroni multiple-comparison correction). This suggests that the PPS condition is more personified than the NPS condition for many users. Also, the PPS is higher than the NPS in the *PPS group*. Additionally, the test showed significant differences in *PPS group* (i.e., $p < 0.001$, r = 0.58, stochastically significant after the Bonferroni multiple-comparison correction). For the *NPS group* (r = 0.22) and *Even group* (r = 0.34), PPS was evaluated as better than that of NPS, but no significant difference was observed (i.e., $p > 0.1$). **Figure 9** shows the evaluation results of animacy. The mean of the PPS is higher than that of the NPS in the *All participants*. In the *PPS group*, the mean of the PPS is also higher than that of the NPS. Similar to anthropomorphism, *All participants* (r = 0.47) and *PPS group* (r = 0.56) were significantly different for PPS vs. NPS (i.e., $p < 0.001$, stochastically significant after the

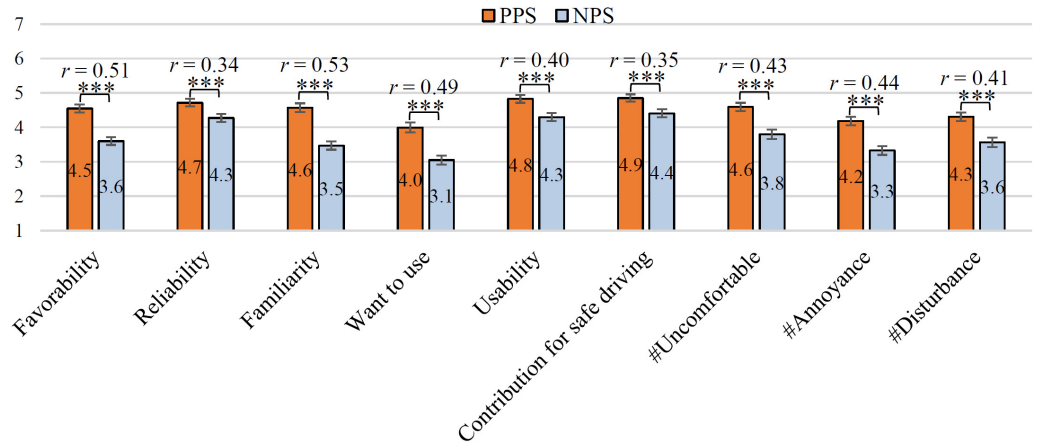

FIGURE 6 | Acceptance of driving support by *All participants* (n = 197). ***$p < 0.001$. The error bar shows the standard error.

Bonferroni multiple-comparison correction). In the *NPS group* (r = 0.22) and in the *Even group* (r = 0.34), the animacy of the PPS was evaluated as better than that of NPS, but the scores were not significantly different for PPS vs. NPS (i.e., $p > 0.1$). In addition, the *Spearman rank correlation coefficient* between driving support acceptance and the evaluation of anthropomorphism and animacy was about 0.1–0.4, and no strong correlation was observed.

Figure 10 shows the results of perceived intelligence. In the *All participants*, the mean of the PPS is higher than that of the NPS. Unlike anthropomorphism and animacy, there were no significant differences in the evaluation by *All participants* (i.e., $p > 0.1$, r = 0.10). On the other hand, there were significant differences between *PPS* and *NPS groups* (i.e., *PPS group* $p < 0.001$, r = 0.34; *NPS group* $p < 0.05$, r = 0.46, stochastically significant after the Bonferroni multiple-comparison correction). Specifically, in the *PPS group*, the mean of the PPS is higher than that of the NPS. Also, the mean of the NPS is higher than that of the PPS in the *NPS group*. The *Even group* was not significantly different (i.e., $p > 0.1$, r = 0.21). Therefore, for perceived intelligence, the PPS/NPS with high acceptability as driving assistance (in the section "Result 1: Acceptability as the Driving Support") was highly evaluated in the *PPS/NPS group*. Furthermore, there was a strong correlation between the acceptance of driving assistance and the evaluation of intelligence (i.e., *Spearman rank correlation coefficient*, $p < 0.001$, NPS condition = 0.56, PPS condition = 0.69).

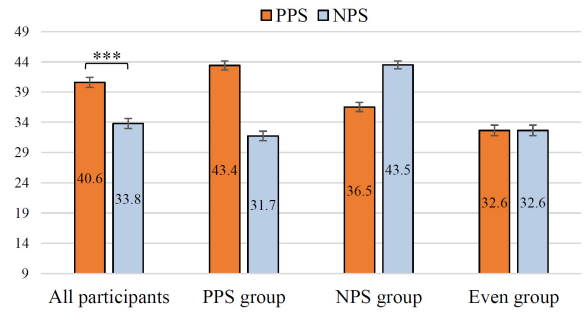

FIGURE 7 | Acceptance of driving support by participant group. *All participants* (n = 197), *PPS group* (n = 134), *NPS group* (n = 32), and *Even group* (n = 31). ***$p < 0.001$. The error bar shows the standard error.

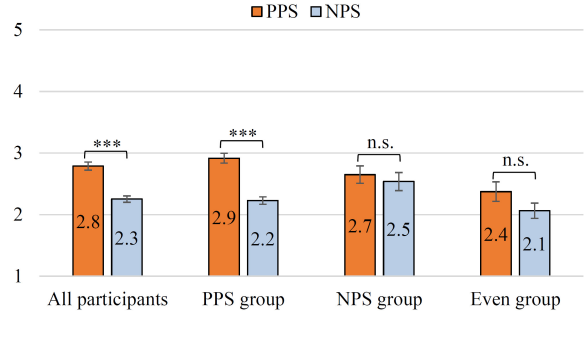

FIGURE 8 | Impression of anthropomorphism. ***$p < 0.001$. The error bar shows the standard error.

DISCUSSION

Contribution to Agent Utterance Design

Compared to NPS, PPS was evaluated as the acceptable driving support utterance based on the evaluation by *All participants* (**Figure 6**). In addition, significant differences were observed in all 9 items used in the experiment, and large effect size was obtained from the medium ($0.34 \leq r \leq 0.53$). Therefore, as a whole, it is considered that PPS kept the face of the experimental participants compared with NPS. This result agrees with the experimental result of Miyamoto et al. (2019) targeting DSA. In previous studies (Salem et al., 2013; Torrey et al., 2013; Srinivasan and Takayama, 2016; Deshmukh et al., 2018; Lee et al., 2019), the agent's utterance was designed based on the politeness strategies, but the difference in acceptability between PPS and NPS was not clear (i.e., no significant difference). However, this paper does not

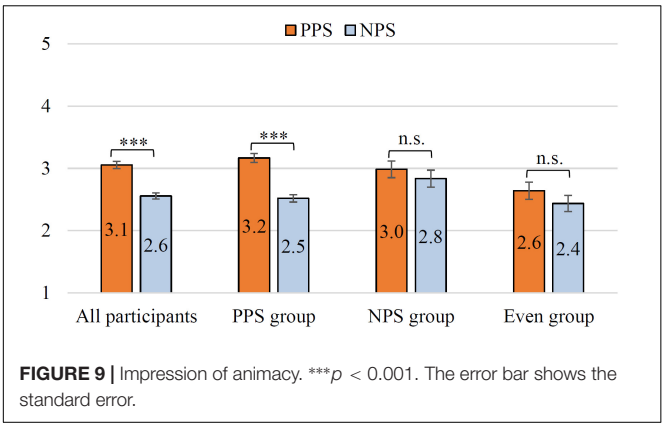

FIGURE 9 | Impression of animacy. ***$p < 0.001$. The error bar shows the standard error.

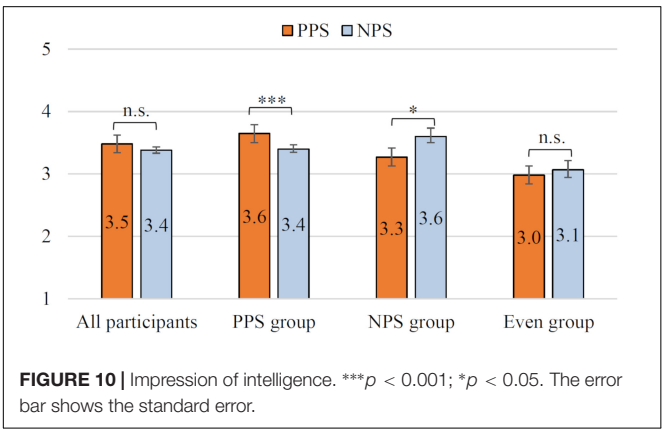

FIGURE 10 | Impression of intelligence. ***$p < 0.001$; *$p < 0.05$. The error bar shows the standard error.

show a method for identifying the state of the user's face. In a related study, a method for calculating *Wx* based on the user's age, gender, and facial expression has been proposed (Miyamoto et al., 2020). In the future, by combining this method with the findings obtained in this paper, we can expect the development of a DSA that autonomously estimates *Wx* and selects an appropriate politeness strategy.

From the section "Result 1: Acceptability as the Driving Support," the ratio of participants in the *PPS*/*NPS*/*Even group* was 4:1:1, respectively. In this study, this is called *Ratio of* Acceptability for Social distance Expressed by Driving support agent (*Ratio of ASED*). The discovery of *Ratio of ASED* contributes mainly as an index for designing utterances in DSA. Specifically, the *PPS group* is a majority. However, it is difficult to decide on a single acceptable utterance strategy in developing a DSA. Therefore, we suggest that it is important to discuss an agent's utterance to be implemented sufficiently from a viewpoint of verbal behavior. According to *Ratio of ASED*, in order to develop DSA that can be accepted by a wide range of users, it is important to design utterances considering that there are a certain number of *NPS group*, although they are minorities. The existence of the *NPS group* supports previous studies (Deshmukh et al., 2018; Lee et al., 2019). In previous studies, it has been shown that politeness strategies were more effective in improving acceptability than direct utterances. However, it was not shown that there was a user group in the acceptability of politeness strategies.

From the section "Result 2: Godspeed Questionnaire," anthropomorphism and animacy were highly evaluated for PPS compared to NPS. This result is consistent with the result of Miyamoto et al. (2017), who suggested that PPS reduces the impression that a non-task-oriented conversational agent is a machine (i.e., increases the humanity of a non-task-oriented conversational agent). The effect of enhancing the agent's humanity is thought to lead to a promotion of a phenomenon in which a user assigns an intention to an agent's behavior and a user anthropomorphizes an agent (Dennett, 1989; Reeves and Nass, 1996; Miyamoto et al., 2017). Thus, increasing the anthropomorphism and animacy of an agent is a useful method to improve the interaction between the agent and the user. For example, if the DSA uses PPS to speak about the user's driving, the user can be expected to attribute positive intentions to the DSA, which resultantly increases the affinity between the user and the agent. Also, since anthropomorphism and animacy are aspects of evaluation that have received much attention in the field of HRI (Bartneck et al., 2009), these results can be referred to for designing robots that interact with humans. However, there was no significant difference in the impression of intelligence among all participants. On the other hand, the PPS/NPS with high acceptability as driving assistance (in the section "Result 1: Acceptability as the Driving Support") was highly evaluated in the *PPS/NPS group*. Furthermore, the strong correlation between the driving support acceptance and intelligence evaluation suggests that designing the behavior of an agent that allows the user to feel intelligence may increase the acceptance of driving support. Increasing agent intelligence also leads to improved reliability (Geven et al., 2006).

Limitations

The knowledge gained through this study contributes to considering psychological acceptability when implementing utterances mainly to DSA. However, we could not give the participants a strong impression of trust and friendliness because the maximum value of the PPS that received a relatively high evaluation in each evaluation item on driving support was just under five points (section "Result 1: Acceptability as the Driving Support"). This is because it is considered that the utterance content is limited to the surrounding information and suggestions for driving. In order to solve this problem, it may be effective to implement various utterances for DSA, not limited to task-oriented utterances such as surrounding information and driving suggestions, specifically the agent to ask any questions to the user (e.g., "*How is your health?*"), or for the agent to utterances containing simile (e.g., "*You drive like a pro!*"). We believe that doing so may improve the acceptability of DSA. Questions and simile are known to lead to an expression of intelligence (Carnegie, 2006). As described in the section "Contribution to Agent Utterance Design," giving the impression that an agent is intelligent to a user is effective in improving the acceptability of driving assistance. Furthermore, the viewing time of the videos was about 2 min each. Therefore, it is possible that the time of the experiment was not enough to give the participants a strong feeling of friendliness and reliability, e.g., the agent can

receive six points or more (maximum score is seven) for the evaluation item in the section "Result 1: Acceptability as the Driving Support." We compared our experimental results with those of Tanaka et al. (2018b), who evaluated the acceptability of driving assistance using the same scale as ours. As a result, our experimental results showed that the overall evaluation of agent is one point lower than Tanaka et al.'s (2018b). In the experiment conducted by Tanaka et al. (2018b), the number of times a participant listened to the agent's utterance was three times higher than our experiment. Unlike our study, Tanaka et al. (2018b) also examined the effect of the number of contacts between the user and the agent, which is thought to affect the evaluation. Therefore, we suggest long-term experiments to verify the improvement in an agent's acceptability by the mere exposure effect (Zajonc, 1968).

In this study, experiments were conducted only in Japanese; thus, it does not necessarily contribute directly to all languages and cultures. However, since politeness theory can be applied on other languages, it is possible to carry out the experiment for other languages. There are also politeness strategies and driving situations that have not been investigated in this study. Furthermore, the user segment of the *Ratio of ASED* is still unknown. By solving these problems, the usefulness of the *Ratio of ASED* can be further enhanced. On the other hand, in order to solve all these problems, we need to conduct experiments that take a huge number of variables into account.

Also, in this paper, the experimental stimulus was constructed only by a specific utterance set. Therefore, in this paper, the effects of PPS and NPS cannot be generalized. One of the solutions to this problem is to create a wide variety of utterances for each politeness strategy and conduct an experiment in which they are randomly presented to the participants. It may also be useful to set the use of honorifics as an independent variable. On the other hand, in DSA studies, there is little knowledge about the effect of the difference in wording on acceptability. Therefore, the discussion in section "Contribution to Agent Utterance Design" is considered to contribute as a finding for DSA research. The above experiment will be carried out as future work. In addition to this paper, there are other studies that have applied politeness theory to the design of dialogue agents (e.g., Srinivasan and Takayama, 2016; Lee et al., 2019). However, to apply the findings of these studies to other studies, it is necessary to clearly present how other researchers can create or utilize PPS and NPS utterances. For example, in the field of natural language processing, the development of a learning device that classifies the politeness of utterance sentences using a dataset labeled with politeness by an annotator (ordinary people) as teacher data for a large-scale dialogue log between people has been developed (Danescu-Niculescu-Mizil et al., 2013). It is thought that the development of such research will enable other researchers, who are unaware of politeness theory, to create utterance examples and dialogue systems that consider politeness.

We conducted an experiment to evaluate the psychological receptivity to a DSA's utterance and obtained useful insights. As a next step, we would like to implement a DSA–user interaction experiment using a driving simulator (e.g., UC-win/road). This will facilitate an objective evaluation based on the user's driving behavior, not just psychological acceptability. However, as described in the section "Introduction," the purpose of this study is to investigate the psychological acceptance of DSA utterances, and this was accomplished through the experiments conducted in the section "Experiment." The video-based experiments may be a shortcoming of this study. On the other hand, experiments using video have been suggested to be effective evaluation methods for psychological indicators in the field of Human–Robot Interaction (e.g., Syrdal et al., 2008; Rosenthal-von et al., 2013). In addition, a previous study (Cramer et al., 2008) adopted video-based experiments to evaluate the acceptability of DSA to elucidate the relationship between DSA type/driving context factors and DSA acceptability. Thus, we believe that the psychological acceptability of DSA can be adequately evaluated through video-based experiments. We thus believe that an experiment using a driving simulator is outside the scope of this study. We would like to conduct it as a separate study in the future.

CONCLUSION

In this study, we discussed the influence of social distance expressed by DSA's utterance on its psychological acceptability by the user. For the utterance design of the agent, we used PPS and NPS in the typical politeness strategy of expressing social distance in interpersonal relationships. The validity of the designed utterance was evaluated by the researchers specializing in politeness theory. Using the designed utterances, we created the videos supported by the agent. Participants watched the videos from the driver's perspective. The experiment was conducted in which participants were recruited with crowdsourcing, and participants evaluated the psychological acceptability of the agent's utterances by watching the videos. As a result, the overall evaluation by the participants was higher in PPS than in NPS. However, there were some participants who evaluated NPS significantly higher than PPS or evaluated both strategies to be equal. Specifically, the ratio of the participants who highly evaluated PPS, participants who highly evaluated NPS, and participants who evaluated PPS and NPS equally was 4:1:1 (i.e., *Ratio of ASED*). This result contributes mainly as an index for implementing utterances to DSA. In the future, we plan to conduct an objective evaluation based not only on psychological acceptability but also on driving behavior by conducting driving experiments using a driving simulator.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation

and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

TM, DK, TT, HK, YY, and KF designed the research. TM, DK, YS, and MU performed the research. TM and DK wrote the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.526942/full#supplementary-material

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