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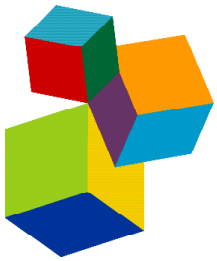

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NEW PERSPECTIVES ON PROCRASTINATION, VOLUME II

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Editorial: New perspectives on procrastination, volume II

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Editorial on the Research Topic
New perspectives on procrastination, volume II

The field of procrastination is growing almost exponentially, with the academic search engine *Semantic Scholar* indicating approximately half of the more than 16,000 articles written on the topic were published in the previous 6 years. At this point, review articles of the field are becoming increasingly important. In addition, foundational issues still are being addressed, in particular the diagnosis and assessment of procrastination and its effects. More sophisticated techniques are being increasingly employed, with hierarchical or multi-level modeling proving particularly useful. Finally, a mature science increasingly moves into intervention or treatment, building on the previous components. Each of these components are featured in this Research Topic.

As a review of procrastination, Yan and Zhang conducted bibliometric analysis of the field based on 1,635 articles. It is a useful examination of where the research has been as well as where it may be going. Those looking to familiarize with the overall field will find this invaluable. For example, as they found and as reflected here, bedtime procrastination is an emerging focus. Also, they note that there have been considerable challenges in studying the topic, with our preponderance of using student samples and self-reports, issues that notably some of the very articles we feature here have overcome. Along these lines, Zentall used comparative psychology to connect procrastination to basic behavioral processes, indicating that though culture, skills and tasks characteristics can exacerbate procrastination, it is tapping into fundamental aspects of our cognitive architecture. Consistent with this conclusion, Lu et al. established meta-analytically that procrastination is common across a wide range of sociodemographic situations and characteristics.

Foundational to any field is its assessment, with Vangsness et al.'s examination of ten popular scales finding various problems, with only the *Irrational Procrastination Scale* demonstrating both a consistent factor structure and a strong predictor of behavioral delay. Svartdal and Nemtcan found that further improvements can be made

in identifying the most dysfunctional forms of procrastination (i.e., differentiating among strategic, inconsequential and irrational delays) by focusing the past negative consequences of unnecessary delay. Across two studies, they developed the *Negative Consequences of Procrastination* (NCP) scale, which pairs well with Rozental et al.'s research. They sought to identify those most need of support, finding that *Pathological Delay Criteria*, which is analogous to past negative consequences, an excellent indicator. Together, these two assessments clearly help to pinpoint those in need of clinical care.

Two papers address the relationship between procrastination and sleep. Meng et al. focused on the antecedents of bedtime procrastination, demonstrating the negative role of low self-efficacy. Furthermore, they explored the roles of moderators of this effect, finding a significant moderating effect of negative affect. Maier et al. explored the consequences insufficient sleep has for procrastination in full-time employees. Using a multilevel design with repeated measures, they demonstrated a negative relation between sleep quality in a given night and procrastination the following day. Importantly, this effect was demonstrated to be stronger for later chronotypes (i.e., evening types).

The use of sophisticated designs in the analysis of antecedents and outcomes of procrastination was further illustrated in the paper by Kljajic et al. Employing a multilevel design, they compared students to one another (between-person level) as well as students over different courses (within-person level). At both levels, they explored the mediating role of procrastination in the associations between two antecedents (autonomous and controlled motivation) and two outcomes (grade and wellbeing). In their case, a main finding was that the antecedent of procrastination differed across levels of analysis. Also using multilevel modeling, Steel et al. examined the causes and impact of procrastination on "slippery deadlines" (i.e., deadlines where the due date is ill-defined and can be autonomously extended). Performance data from a unique venue, Canadian arbitration cases, as well as associated survey data allowed for analyses in terms of individual differences, self-regulatory skills, workloads, and task characteristics on the outcome variable, time delay. The results of this study, as well as in a replication using an independent data set, indicated trait procrastination to be a substantive predictor of observed delay. Analyzing academic procrastination, Wieland et al. applied an event-based experience sampling method to assess the momentary appraisals of the tasks at hand as well as their next day intention to work on the tasks. In addition, a second query administered the following day repeated the appraisal queries as well as probed whether the intentions the previous day had been implemented or delayed. A devaluation of the study-related tasks increased the risk for an actual delay, and a measure of general procrastination tendency did not predict individual differences in their task-specific delay behavior. These three papers all demonstrate multilevel modeling as a welcome addition to cross-sectional surveys.

Finally, Schunemann et al. describe a promising approach to overcome procrastination. Consistent with previous studies that have indicated that procrastination is rooted in use of dysfunctional emotion regulation strategies, particularly in dealing with negative emotions, the authors argue that training of adaptive emotion regulation skills should help alleviate procrastination. Using a randomized controlled design, the intervention group received an online emotion regulation training over a period of 9 weeks. Results demonstrated that the enhancement of general emotion regulation skills significantly reduced subsequent procrastination behavior, and subsequent mediation analyses indicated that the reduction of procrastination was significantly mediated by the increase in general emotional regulation skills.

Altogether, these papers indicate that the study of procrastination is continuing to mature. A better measurement base is being established as well as a deeper understanding of the underlying mechanisms. Research designs are becoming more sophisticated and there are increasing signs of the most important indicator of maturity: effective interventions. At this point, we believe the field is ready to tackle enthusiastically how to treat or diminish procrastination. We have multiple venues where procrastination is rampant and participants are plentiful, particularly Massive Open Online Courses (MOOCs).

Looking forward, we expect that there will be interactions between people and treatment, meaning that one size does not fit all. Procrastinators share common characteristics (e.g., impulsiveness), but relevant individual differences should be considered. Furthermore, diagnostics and interventions should assess not only degree and causes of procrastination but also the presence or absence of compensating self-regulatory skills as this will help to adeptly match individuals with the myriad of possible treatments (e.g., if someone has already mastered a skill, further training is unlikely to be beneficial). Even situational characteristics should be integrated in the understanding of procrastination, as some environments (e.g., the academic) tolerate procrastination more than others. We will need to establish what interventions pair well together, what is sustainable and people's readiness to adopt them. This can touch on everything from work design to recuperation. It appears that procrastination and our study of it will continue to grow for quite a while.

Author contributions

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

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.

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Predicting Delay in Goal-Directed Action: An Experience Sampling Approach Uncovering Within-Person Determinants Involved in the Onset of Academic Procrastination Behavior

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Academic procrastination involves the delayed implementation of actions required to fulfill study-related tasks. These behavioral delays are thought to result from momentary failures in self-regulation (i.e., within-person processes). Most previous studies focused on the role of trait-based individual differences in students' procrastination tendencies. Little is known about the within-person processes involved in the occurrence of procrastination behavior in real-life academic situations. The present study applied an event-based experience sampling approach to investigate whether the onset of task-specific delay behavior can be attributed to unfavorable changes in students' momentary appraisals of tasks (value, aversiveness, effort, expectations of success), which may indicate failures in self-regulation arise between critical phases of goal-directed action. University students ($N = 75$) used an electronic diary over eight days to indicate their next days' intentions to work on academic tasks and their task-specific appraisals ($n = 582$ academic tasks planned). For each task, a second query requested the next day determined whether students' task-related appraisals changed and whether they implemented their intention on time or delayed working on the respective task ($n = 501$ completed task-specific measurements). Students' general procrastination tendency was assessed at baseline using two established self-report questionnaires. Stepwise two-level logistic regression analyses revealed that within-person changes in task-related appraisals that reflected a devaluation of the study-related tasks increased the risk for an actual delay. The risk to delay decreased when students maintained a positive attitude toward the task. Students' general procrastination tendency did not predict individual differences in their task-specific delay behavior. We discuss these findings in light of the growing effort to understand the within-person processes that contribute to induce procrastination behavior under real-life academic conditions and illustrate how this knowledge can benefit the design of tasks and instructions that support students' self-regulation to their best.

Keywords: delay behavior, procrastination, self-regulation, intention-action gap, experience sampling

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INTRODUCTION

Delaying work on a task involves the intention to perform a goal-directed action but to postpone its implementation until a later time (Lay, 1986; Steel et al., 2001). This delay causes an intention-action gap, the core criterion for procrastination, which is further characterized by the awareness that the delay is to one's own disadvantage (Steel, 2007; Simpson and Pychyl, 2009; Klingsieck, 2013). These disadvantages become most evident in academic settings where definite deadlines limit the time available to accomplish study-related tasks. There is ample evidence for a negative relationship between the pronounced tendency to delay study-related tasks (i.e., academic procrastination) and students' academic performance (Tice and Baumeister, 1997; Steel et al., 2001; van Eerde, 2003; Richardson et al., 2012). In addition, increased procrastination tendencies were found to be positively related to indicators of impaired mental and physical well-being (e.g., Tice and Baumeister, 1997; Sirois et al., 2003; Grunschel et al., 2013; Krause and Freund, 2014; Beutel et al., 2016). These findings become even more concerning given that many students (30 to 45% of respondents) have been found to procrastinate on study-related tasks (e.g., writing term papers or studying for exams) frequently and view their behavior as problematic (Solomon and Rothblum, 1984; Beswick et al., 1988; Day et al., 2000; Schouwenburg, 2004).

To elucidate why many students engage in such an evidently dysfunctional behavior, research has typically focused on relating between-person differences in students' general procrastination tendencies to a set of characteristic trait patterns (for overviews, see Ferrari et al., 1995; van Eerde, 2003; Steel, 2007; Klingsieck, 2013). At the same time, a growing body of research has suggested that students' procrastination behavior (i.e., actual delays in working on tasks) results from more temporary failures in self-regulation (e.g., Steel et al., 2001; Dewitte and Schouwenburg, 2002; Howell et al., 2006; Howell and Buro, 2009; Sirois and Pychyl, 2013). Effective self-regulation would require that individuals apply regulatory strategies that allow them to adapt their cognition, motivation, their affective responses, and their behavior to deal successfully with a given task (e.g., Winne and Hadwin, 1998; Boekaerts, 1999; Zimmerman, 2002; Pintrich, 2004; Efklides, 2011). Thus, to understand procrastination behavior as a consequence of self-regulatory failure, it would be appropriate to consider both trait-based individual differences and more situation-, task-, or context-dependent determinants that change within the individual over time (i.e., within-person processes). One explanatory approach that highlights this requirement is the mood-repair hypothesis proposed by Sirois and Pychyl (2013). This approach builds upon the transactional stress model of Lazarus and Folkman (1984) and explains procrastination behavior as a maladaptive coping strategy that serves to avoid an unpleasant affective state that arises when the demands of a task seem to exceed one's abilities, competencies or available resources. Cross-sectional designs and self-report questionnaires – assessing individual differences in students' general procrastination tendency – preclude the possibility of recognizing the within-person processes or context-specific influences involved in the occurrence of delay behavior under real-life conditions (see also van Eerde, 2003; Molenaar, 2004; Schmitz, 2006).

The few studies that have used behavioral measures to examine students' delay behavior over time, and under real-life conditions, have revealed that students' task-specific delay behavior was subject to time-dependent fluctuations in general (e.g., Steel et al., 2001; Moon and Illingworth, 2005; Howell et al., 2006; Krause and Freund, 2014), and discontinuously declined over time toward the deadline (as proposed by Temporal Motivation Theory, Steel and König, 2006; Steel et al., 2018). Other studies used experience-sampling approaches to show that an increased occurrence of procrastination behavior was related to everyday stresses (such as negative affect, Pollack and Herres, 2020; or poor sleep quality, van Eerde and Venus, 2018), providing additional support for the theoretical propositions of the mood-repair hypothesis (Sirois and Pychyl, 2013). However, these studies are still in the minority. The potential impact of task- or context-dependent variability in behavioral determinants (i.e., within-person variability) on students' actual behavior (and on the occurrence of behavioral delays) has rarely been studied (van Eerde, 2003; Voelkle et al., 2014), although there has been an encouraging increase in studies that have made an effort to address this research gap over the past ten to twenty years (e.g., Pychyl et al., 2000; Krause and Freund, 2014; Steel et al., 2018; van Eerde and Venus, 2018; Pollack and Herres, 2020; Svartdal et al., 2020). The present study sought to complement previous research on potential indicators for self-regulatory failures that are thought to precede the occurrence of task-specific delay behavior under real-life conditions. The study goes beyond the analysis of between-person differences to examine whether changes in behavioral determinants that arise in the course of action within individuals and may indicate a failure of self-regulation can predict the actual occurrence of task-specific behavioral delays.

FROM BETWEEN- TO WITHIN-PERSON PERSPECTIVES IN RESEARCH ON PROCRASTINATION

A large body of previous research on procrastination has been based on the assumption that individuals possess a more or less pronounced procrastination tendency (Ferrari, 1991; Schouwenburg and Lay, 1995; van Eerde, 2003; Schouwenburg, 2004). Numerous studies have examined between-person differences in students' self-reported procrastination tendencies using procrastination scales or inventories (for reviews, see van Eerde, 2003; Steel, 2007; Klingsieck, 2013). These studies demonstrate associations between self-reported procrastination tendencies and certain personality traits (a lack of conscientiousness, elevated levels of neuroticism, or impulsivity), some have even described procrastination as a trait-like construct in itself (see Johnson and Bloom, 1995; Watson, 2001; van Eerde, 2003; Schouwenburg, 2004; Steel, 2007).

More comprehensive explanations suggest that procrastination results from self-regulatory failure, as the individual fails to direct one's cognition, motivation, and behavior

to the attainment of some long-term goal (e.g., Dewitte and Lens, 2000; Wolters, 2003; Howell et al., 2006; Steel and König, 2006; Sirois and Pychyl, 2013). Studies following this rationale have provided evidence that pronounced procrastination tendencies are related to unfavorable motivational beliefs or attitudes. Students who are primarily motivated by extrinsic rewards (Senécal et al., 1995; Brownlow and Reasinger, 2000), hold mastery-avoidance or work-avoidance orientations (Wolters, 2003; Howell and Watson, 2007; Howell and Buro, 2009), or report a lack of self-efficacy for self-regulation (Klassen et al., 2008), were frequently found to report pronounced procrastination tendencies. Moreover, students with pronounced procrastination tendencies appear to use hardly any (meta-)cognitive strategies when working on academic tasks (Wolters, 2003; Howell and Watson, 2007; Corkin et al., 2011), which makes it difficult to regulate their behavior effectively. The relevance of intra-individual processes of self-regulation in the occurrence of procrastination behavior is most explicitly stated in the mood-repair hypothesis presented by Sirois and Pychyl (2013). This proposition has been supported by empirical findings linking students' procrastination tendencies to their experience of negative emotions or their inability to regulate these emotions adequately (e.g., Lay, 1992; Tice et al., 2001; McCown et al., 2012; Rebetez et al., 2015; Eckert et al., 2016; Pollack and Herres, 2020).

While postulating that self-regulatory failures (i.e., within-person processes) determine the occurrence of procrastination behavior, most previous studies have related individual differences in students' procrastination tendencies to individual differences in determinants deemed relevant for self-regulation (i.e., general interests, abilities, or attitudes). However, the success or failure of self-regulation does not depend on students' trait-like characteristics, abilities, or attitudes alone. Instead, self-regulatory processes mediate the complex interplay between trait-like determinants (including abilities and attitudes), contextual or situational influences (e.g., task characteristics or affective states), and students' actual learning behavior or performance (e.g., Winne and Hadwin, 1998; Boekaerts, 1999; Zimmerman, 2002; Pintrich, 2004; Efklides, 2011). Thus, to understand behavioral delays as a result of self-regulatory failure, it will be indispensable to consider behavioral determinants that may change dynamically over time within individuals, depending on task- or context-specific influences. Specifically, this would require to capture the occurrence of a delay, that is, the absence of an intended action (Lay, 1986; Svartdal et al., 2018), and to examine whether within-person changes in behavioral determinants contribute to the occurrence of this delay.

THE ONSET OF DELAYS IN GOAL-DIRECTED ACTION

Any Delay Requires an Intention

At the beginning of every self-regulated action, an individual has to form the intention to strive for a goal, to reach a certain condition or performance standard (Heckhausen and Gollwitzer, 1987; Austin and Vancouver, 1996; Pintrich, 2004). The actual translation of this intention into goal-directed action will be crucially influenced by its strength (i.e., its temporal stability), which is itself determined by subjective cost-benefit considerations (Gollwitzer, 1990; Ajzen, 1991; Sheeran and Abraham, 2003; Cooke and Sheeran, 2004; Steel and König, 2006). The costs and benefits of pursuing one goal must be weighed against those of pursuing various other alternatives. Two key determinants are relevant for these considerations: the expectation that one will be able to perform the behavior that leads to the desired outcome successfully and the subjective value attached to that outcome (Atkinson, 1957; Gollwitzer, 1990; Bandura, 1997; Eccles and Wigfield, 2002; Locke and Latham, 2002; Steel and Weinhardt, 2018). The higher the subjective value of the anticipated outcome and the expectation that goal-directed behavior can be successfully implemented, the higher the willingness of the person to invest effort and to translate an intention into action (Brehm and Self, 1989; Gollwitzer, 1990; Klein et al., 1999; Eccles and Wigfield, 2002; Dietrich et al., 2017).

Modern expectancy-value theory (e.g., Eccles and Wigfield, 1995; Wigfield and Eccles, 2000; Eccles, 2005) conceptually separated the expectancy determinant into more domain-specific ability beliefs and task-specific expectations of success. However, students' ability beliefs and expectations of success have been found to be highly correlated in real-life academic settings (Eccles and Wigfield, 2002; Dietrich et al., 2017). Since the present study was designed to examine students' task-specific delay behavior, we will focus on students' task-specific *expectations of success* throughout the following. Moreover, the value determinant has been separated into four conceptual sub-components: attainment value, intrinsic value, utility value, and costs (Eccles and Wigfield, 2002; Eccles, 2005); all but the latter have been found to be highly correlated within an academic domain or learning situation (e.g., Trautwein et al., 2012; Dietrich et al., 2017). For the present study, we focus on the attainment value sub-component, which reflects the personal importance of successful task accomplishment (e.g., Wigfield and Cambria, 2010). However, the costs associated with a task (e.g., the perception of how much effort is required for successful task accomplishment) can be distinguished empirically from the remaining value components (e.g., Trautwein et al., 2012; Flake et al., 2015; Dietrich et al., 2017). Therefore, we follow Barron and Hulleman's (2015) suggestion and consider students' appraisal of task-specific effort costs (the term *effort* is used throughout the following) as a third determinant of their behavioral intentions. Another determinant that has been shown to increase the risk that an intention will not be realized in time is the individual's perceived aversion toward engaging in a task (e.g., Lay, 1992; Milgram et al., 1995; Blunt and Pychyl, 2000). While task aversiveness is a multifaceted construct (for a detailed analysis, see Blunt and Pychyl, 2000), most findings suggest that tasks perceived as aversive seem to be less personally meaningful and generally affectively unpleasant (Lay, 1992; Milgram et al., 1995; Blunt and Pychyl, 2000). Therefore, it seems highly likely that perceptions of task aversiveness will affect one's commitment to engage in goal-directed action (see also Blunt and Pychyl, 2000). Task aversiveness was thus included as the fourth relevant determinant of students' willingness to engage with their tasks in the present study.

However, the mere formation of a strong intention does not guarantee task accomplishment (Heckhausen and Gollwitzer, 1987; Gollwitzer, 1990; Ajzen, 1991; Cooke and Sheeran, 2004). The number of intentions to work on academic tasks expressed by students with pronounced procrastination tendencies is comparable to that of other students, but they are significantly more likely to delay their realization (Steel et al., 2001; Dewitte and Schouwenburg, 2002). Therefore, the delay cannot result alone from a lack of initial willingness. Instead, meta-analytical evidence suggests that it is the temporal stability of intentions that moderates their predictive value for the performance of corresponding behavior (Cooke and Sheeran, 2004).

Any Delay Is the Deviation From an Intention

The model of action phases (Heckhausen and Gollwitzer, 1987; Gollwitzer, 1990) describes a temporal sequence of different stages that have to be passed during goal-directed action. After intention formation (predecisional phase), volitional action stages involve the planning of specific strategies (preactional phase), which must then be translated into goal-directed action (actional phase) in order to realize the intention (Heckhausen and Gollwitzer, 1987; Gollwitzer, 1990). Various difficulties can arise both within and in the transition between these phases, posing a challenge for self-regulation (discussed in detail by Gollwitzer and Sheeran, 2006; Wieber and Gollwitzer, 2010). Self-regulation theories (e.g., Winne and Hadwin, 1998; Boekaerts, 1999; Zimmerman, 2002; Pintrich, 2004; Efklides, 2011) have focused precisely on those dynamic adaptions that support the realization of task-specific behavioral intentions. Especially in the face of difficulties, distractions, or attractive alternative options to satisfy one's needs, it may become necessary to increase one's (self-regulatory) efforts to adhere to the original intention (see Gollwitzer, 1990; Sheeran et al., 2005). Under such circumstances, the person must ascertain whether the additional effort required to realize the intention is as yet justified.

Effective self-regulation would involve intraindividual processes that constantly (re)assesses whether an intended action (e.g., working at a task) should be initiated, maintained, changed, or terminated under the given circumstances (e.g., Pintrich, 2000; Zimmerman, 2002; Inzlicht et al., 2014). Moreover, the (cognitive, affective, motivational) capacities of the individual stand in a reciprocal relationship to situational or contextual influences, and it is this reciprocal relationship that ultimately affects the behavior (e.g., Kuhl, 1992; Winne and Hadwin, 1998; Boekaerts, 1999; Pintrich, 2004; Sirois and Pychyl, 2013). Therefore, an individual's decision to delay or work on a specific task should not be influenced only by the intention that was based on the outcome of previous cost-benefit considerations. Instead, the willingness to engage in goal-directed action may change depending on the current circumstances.

Some studies have recently revealed that motivational determinants related to students' performance behavior are not merely a stable characteristic of the individual, but also significantly influenced by situation and task characteristics (e.g., Vancouver and Kendall, 2006; Tanaka and Murayama, 2014; Martin et al., 2015; Dietrich et al., 2017). Most notably, a significant amount of variance in the determinants of students' goal-directed actions was within-person variance at the (domain, day, or) task level (e.g., Vancouver and Kendall, 2006; Tanaka and Murayama, 2014; Dietrich et al., 2017). Moreover, affective experiences have been identified as one of the major determinants for the occurrence of procrastination behavior (Sirois and Pychyl, 2013). Procrastination was found to be particularly likely to occur for tasks that students perceived as being particularly aversive, unpleasant, difficult, boring, or effortful (Lay, 1992; Blunt and Pychyl, 2000; Ferrari and Scher, 2000; Pychyl et al., 2000), and was related to everyday stresses (such as negative affect, Pollack and Herres, 2020; or poor sleep quality, van Eerde and Venus, 2018), providing additional support for the claim that the occurrence of procrastination behavior is not only determined by individual trait-based influences, but also affected by rather situational or context-specific influences. Further research focusing on within-person processes is necessary to gain a more comprehensive insight into the relationship between self-regulatory failures and the occurrence of procrastination behavior under real-life academic conditions. It is needed to extend research that focused on individual differences in procrastination tendencies to the momentary, task- and situation-specific changes in behavioral determinants that occur within individuals over time to obtain a more complete picture of the conditions that increase students' risk to delay working on their academic tasks.

THE PRESENT STUDY

The primary objective of the present study was to investigate whether the occurrence of behavioral delays would be predicted by within-person changes in students' cognitive-affective appraisals of tasks that arise between different phases of goal-directed action. We further sought to examine whether within-person changes in the appraisal of tasks have an effect on the occurrence of task-specific delay behavior that goes beyond the influence of between-person differences in general procrastination tendencies.

While between-person differences in procrastination tendencies were assessed using established self-report questionnaires, an event-based experience sampling approach was implemented (a) to identify within-person changes in students' cognitive-affective appraisals of tasks, and (b) to capture the momentary occurrence of task-specific delay behavior in their everyday life. For one week, students' intentions to work on academic tasks and their initial task-specific appraisals were captured each evening using electronic diaries (e-diaries). For each task, a second assessment was requested the next day to determine whether students realized the intention or delayed working on the respective task.

We expected that students' initial appraisal of a task (i.e., the expectation of success, task value, anticipated effort, and task aversiveness) in the early phase of planning (i.e., during intention formation) would predict the occurrence of task-specific delay behavior (*Hypothesis 1*). We further account for the fact that these appraisals may change between the phase of intention

formation and the moment that the intention should be actually realized by goal-directed action. It was expected that the risk to delay a task should (a) decrease as the perceived task value increases between the intention formation and the moment that the intention should be realized, but (b) increase as the subjective aversiveness of the task or the anticipated effort increase between the intention formation and the moment that the intention should be realized (*Hypothesis 2*). These within-person changes in students' cognitive-affective appraisals of tasks were expected to be strong indicators for the occurrence of task-specific delay behavior, in addition to effects that were expected by individual differences in general procrastination tendencies (*Hypothesis 3*).

MATERIALS AND METHODS

Participants and Procedure

Participants were recruited within cross-curricular courses that were offered for all students enrolled at a large German University (with technical focus) to foster students' self-regulation and time-management skills. The study was conducted in two waves because of limited course capacity, including $n = 29$ students from a course provided during winter term and $n = 46$ students from two courses provided during the summer term. The overall sample comprised $N = 75$ students ($M_{age} = 23.07$, $SD_{age} = 2.28$, $n = 74$) of diverse majors[1] ($n = 43$ Bachelor; $n = 31$ Master). Demographic information was missing for one participant, five participants did not indicate their gender ($n = 50$ male).

The compact cross-curricular courses started during the third week of lectures during winter and summer term, respectively. Students were informed about the study in the first session and were introduced to the handling of the e-diary that was preinstalled on smartphones with Android systems (Movisens GmbH, 2015/2016). Students who agreed to participate, and gave their informed consent, filled out paper-pencil questionnaires to gather demographic information and to assess their procrastination tendency at baseline. Finally, participants received a smartphone with the e-diary.

On Sunday evening after the introductory session, an audible signal emitted by the smartphones reminded participants that they were supposed to respond to the first e-diary query. That query was the starting signal for the following eight days of experience sampling beginning on Monday. The second session of the cross-curricular courses was scheduled for the week after the eight days of experience sampling (nine days including the starting signal). Course content regarding self-regulation and time-management strategies that might affect participants' behavior was not provided before the second session.[2] Following local legislation and institutional requirements, ethical review and approval were not required for the present study. However, all procedural steps of the study were reviewed for compliance with local data protection laws and followed international ethical standards (American Educational Research Association, 2011). Participants were rewarded for their participation with additional course credit. Cinema vouchers (5.0 € value) were provided as an incentive for students with an overall compliance of at least 80% completed e-diary queries.

Experience Sampling Procedure

Participants' delay behavior was captured using an event-based experience sampling approach that allowed for the observation of delays in realizing intended goal-directed actions at the moment of their occurrence. The outcome of interest was the event when a participant decided to realize an intention (i.e., working on the task), or to delay the realization of that intention (i.e., not working on the task at the intended time). Therefore, the e-diary was programmed to cover two separate assessment units for each task. Planning task-specific intentions (T0 measurement) was triggered by fixed-time prompts every evening (between 8:30 pm and 9:00 pm). Participants were initially asked to indicate at least two tasks (e.g., 'study for exam' or 'exercise') that they intended to work on the next day. It was not specified that these had to be academic tasks, but it was stated in the introductory session that academic tasks were of primary interest to our research. Whenever participants missed a fixed-time prompt, they could press a button appearing on the screen between 9:00 pm. and 11:00 pm. to elicit the planning-phase themselves. When planning a task, participants were further asked to indicate the intended time (hh:mm) for working on their task the following day. The specified time defined the moment that the intention was to be realized by taking goal-directed action and triggered the second unit of assessment (T1 measurement).

Both units of assessment encompassed questions regarding participant's subjective appraisals of the tasks. Planning task-specific intentions (T0 measurements) included the appraisal of the subjective task value, students' task-specific expectation of success, task aversiveness, and the anticipated effort required to work on the task. At the moment that the intention was to be realized (T1 measurements), each prompt was followed by displaying the planned task on the screen; students were then again requested to provide their momentary task-specific appraisals (on the subjective task value, task aversiveness, and anticipated effort required). Hereafter, participants were asked to indicate whether they follow their intention and work on the task or delay working on that task.[3]

The first T0 measurement was triggered on Sunday evening (after the introductory session), so that participants could plan

[1]Most of the participants studied Architecture or Constructional Engineering (22.97%), Mathematics or Informatics (22.97%), Mechanical Engineering, Chemistry and Biosciences (17.57%), followed by Industrial Engineering and Economics (12.16%), Physics (9.46%), Arts and Humanities (8.11%), or Electrical Engineering and Information Technology (6.76%).

[2]The study protocol included another second phase of experience sampling within the week of the third and final course session, finalized by (post-intervention) questionnaires. However, baseline assessments of procrastination tendencies and experience sampling data collected during the first eight days after the introductory session (i.e., before the intervention) were of exclusive relevance for answering the current research questions. We therefore focus on the first part of the study protocol for the remainder of the article.

[3]The T1 measurement terminated when participants indicated that they would work on a task. When participants delayed their goal-directed action, they could decide to reschedule the event (i.e., enter a new trigger-time for the task, to begin later that day), or to delete the task from their daily schedule. Information collected during a third assessment unit (T2) – after a task was declared as completed – was not relevant for the current research question, and will not be further described in the present article.

their tasks for Monday. The last day of experience sampling (Monday one week later) included T1 measurements for the tasks planned the previous day, but did not include another T0 measurement. Therefore, students used the e-diary for nine days, but task-specific assessments were requested for a total of eight days only, since each task-specific assessment included two measurements, the first in the evening (T0) and the second the following day (T1).

Over the eight days of experience sampling (nine days including the initial T0 assessment), the $N = 75$ participants (Level 2) planned $n = 1050$ tasks (Level 1) out of 1200 tasks that could have potentially been planned (see **Figure 1** for a detailed flowchart). Both assessment units (T0 and T1 measurements) were completed for a total of $n = 908$ tasks. Therefore, the average compliance rate (completed task-specific measurements) was 86.48%, based on $n = 1050$ tasks planned. As our research question focused on delays in working on academic tasks, only those measurements that were indicated as being study-related were used in the analyses. As such, the final subset of observations (Level 1) included $n = 501$ academic tasks (see **Figure 1**). In 78.8% of the cases (T1 measurements), participants indicated that they worked on their study-related task ($n = 501$) at the time intended, whereas 21.2% of the tasks were indicated as being delayed.[4] Thus, according to the results of a simulation study by Schoeneberger (2016), our sample ($N = 75$ participants at Level 2 and $n = 501$ task-specific measurements at Level 1) meets the requirements to achieve sufficient power to detect the expected effects in logistic multi-level models (described in more detail in the data analysis section).

Measures

Delay Behavior

During each intention-formation (T0 measurement), participants were asked to indicate a "goal or task" that they intended "to work on the following day" within a short text field. Task-specific delay behavior was measured during the intention-realization measurement (T1) by asking participants whether they will "begin to work on the task or goal right now" (the respective task was presented on the screen). The response scale for this item was binary, with a *yes* response (coded 0) indicating that the participant followed the intention to work on the task, whereas a *no* response (coded 1) indicated behavioral delay.

Momentary Task-Specific Appraisals

Single items were used to assess students' momentary task-specific appraisals within both task-specific measurements (T0 and T1). The application of single-item measures can be justified for experience sampling studies to minimize participant burden, increase participants' willingness to respond accurately, and prevent increased drop-out rates (e.g., Gogol et al., 2014). It has also been demonstrated that single-item measures can have favorable psychometric properties under certain conditions (e.g., Robins et al., 2001; Hoeppner et al., 2011; Lucas and Donnellan, 2012; Goetz et al., 2016).

The items used to assess students' task-specific appraisals were held virtually parallel in wording between the first (T0) and the second measurement (T1). The only adjustment was that items presented during T0 measurements referred to the task planned for *tomorrow,* whereas items presented during T1 measurements referred to the task that the participant intended to work on *right now*. Each item was answered on a visual analog scale, ranging from 0 to 100, with verbal anchors adjusted to the appraisal requested (for descriptive statistics of the single-item measures, see **Table 1**). All the items presented in the e-diary were presented in German language and were only translated into English for this publication (the German wording of the items can be found in the Appendix).

The subjective *value* of the task was assessed by asking participants, "How important is it to you personally that you work on that task/reach that goal [right now/tomorrow]" – (*not important at all* to *very important*). The *expectation* of success was assessed (exclusively during T0 measurements) by the item: "How likely do you think it is that you will work on that task/reach that goal tomorrow" – (*very unlikely* to *very likely*). These items were adapted from previous studies (Oettingen et al., 2015; Kappes and Oettingen, 2014; Sevincer et al., 2014). We further assessed the anticipated *effort* required for working on a task as the third behavioral determinant (e.g., Eccles, 2005; Barron and Hulleman, 2015) by the item: "[Prospectively,] How much effort do you have to invest [right now] to work on this task/reach this goal?" – (*very little* to *very much*). While task aversiveness is probably a more multifaceted construct (cf. Blunt and Pychyl, 2000), a person's aversion about a task has often been assessed by asking whether a task is perceived as more or less "pleasant" or "unpleasant" in previous work (Solomon and Rothblum, 1984; Lay, 1990; Blunt and Pychyl, 2000). Therefore, we decided to capture participants' subjective appraisal of the pleasantness (vs. aversiveness) of a task by the item: "How (un-)pleasant is this task/working on this goal [right now]" – (*very unpleasant* to *very pleasant*). Task aversiveness ratings have been reverse coded for the analyses so that higher values indicate that a task was perceived as more aversive (less pleasant).

Procrastination Tendencies

Students' procrastination tendencies were assessed at baseline, using the German version of the Tuckman Procrastination Scale (TPS-d: Stöber, 1995; TPS, Tuckman, 1991) as a more general measure of (trait-like) procrastination tendencies, and the German version of the Academic Procrastination State Inventory (APSI-d: Helmke and Schrader, 2000) as a more proximal measure for students' (state-like) academic procrastination tendencies.

The Tuckman Procrastination Scale (TPS in the following) consists of 16 items describing behaviors or attributions that indicate a tendency to delay the start or completion of tasks or goal-directed actions in general (e.g., "When I have a deadline, I

[4]We would like to thank a very attentive reviewer for drawing our attention to the fact that the proportion of tasks that have been delayed may seem relatively low with about 20%. In fact, we also expected a somewhat larger number of delays. While possible reasons for the low number of reported delays will be discussed in the limitations section, we would like to refer to a recently published experience-sampling study that reported a similarly low proportion of delayed learning sessions (i.e., 26%) among students studying for an exam (Gadosey et al., 2021).

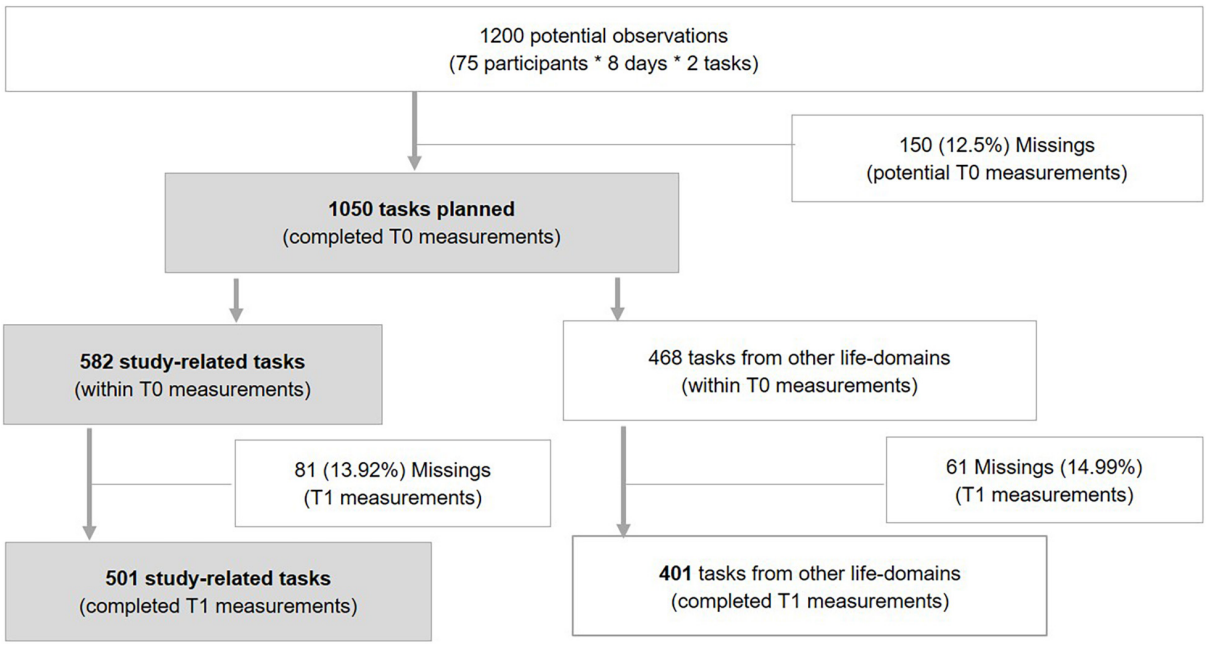

FIGURE 1 | Data flow indicating the subset of Level 1 observations available for the analyses conducted to answer the research questions under investigation. In total, $n = 501$ Level 1 observations fulfilled the eligibility criteria (shadowed boxes): participants (Level 2; $N = 75$) planned a task (T0 measurements); indicated that the task was study-related, and completed the intention-realization assessments (T1 measurements) for these tasks.

TABLE 1 | Descriptive statistics (grand mean, SD, range), ICC and level-specific bivariate correlations for the unstandardized task-specific appraisals (Level 1; $n = 501$ study-related tasks) indicated by the participants (Level 2; $N = 75$) during planning (T0) and intention realization assessments (T1).

	M	*SD*	*Min; Max*	ICC	1	2	3	4	5	6	7
1 Value (T0)	74.93	17.01	6.0; 100.0	0.40	–	0.53**	0.03	0.06	0.11	0.12*	0.43***
2 Value (T1)	72.70	18.89	2.0; 100.0	0.43	0.88***	–	−0.04	−0.09	0.12*	0.09	0.42***
3 Avers (T0)	59.19	17.50	0.0; 100.0	0.37	−0.19	−0.19	–	0.41***	0.35***	0.32***	−0.18**
4 Avers (T1)	59.20	18.33	0.0; 100.0	0.43	−0.11	−0.20	0.98***	–	0.20**	0.41***	−0.14*
5 Effort (T0)	66.56	18.56	7.0; 100.0	0.32	0.41**	0.37*	0.28	0.30	–	0.56***	−0.12*
6 Effort (T1)	65.28	18.02	6.0; 100.0	0.21	0.35*	0.22	0.45**	0.43**	0.97***	–	−0.04
7 Expect (T0)	70.36	18.74	2.0; 100.0	0.30	0.41*	0.33*	−0.58***	−0.52***	0.18	0.09	–

Correlations above the diagonal indicate correlations at the within-person level (Level 1); correlations below the diagonal indicate correlations at the between-person level (Level 2). ICC, intraclass correlation coefficient; Value, task value; Avers, task aversiveness; Effort, effort required for working on the task; Expect, expectation of success; T0, first task-specific measurement during intention formation (planning); T1, second task-specific measurement at the time intended for working on a task (intention realization).
$^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

wait till the last minute" Tuckman, 1991, p. 477). Answers were provided on a five-point Likert-type scale, ranging from *this is not at all true* (1) to *this is very true* (5). Participants ($N = 74$, information missing for one participant) reached an average sum score of 56.87 ($SD = 8.68$; Range = 32.00–75.00) in the present study, Cronbach's alpha was 0.83 within our sample.

The 12-item *state-procrastination* subscale of the German version of the Academic Procrastination State Inventory (APSI-d: Helmke and Schrader, 2000; originally developed by Schouwenburg, 1995) asks for the frequency of interruptions or distractions that occurred during learning activities *within the lask week*. Therefore, the APSI-d assesses procrastination tendencies in a more time- and context-specific way. In the present study, the sample ($N = 74$, information missing for one participant) reached a mean score of 1.89 ($SD = 0.63$; Range: 0.42–3.08) for the *state-procrastination* subscale (hereafter APSI-p). Cronbach's alpha was 0.79 within our sample.

Data Analysis

We accounted for the nested data structure of task-specific measurements (Level 1, $n = 501$) within participants (Level 2, $N = 75$) in the analyses using Mplus (Mplus Version 8.1; Muthén and Muthén, 1998–2018). We were primarily interested in predicting events of delay based on students' task-specific expectations of success (assessed during intention formation, T0), and on within-person changes in their subjective appraisals (task value, task aversiveness, and required effort) between intention formation (T0) and intention realization (T1)

measurements. Predictor variables were prepared by initially z-standardizing all T0 measurements (see **Table 1** for descriptive statistics of the unstandardized variables). These z-standardized T0 measurements were decomposed into their between-level (Level 2, person mean) and within-level (Level 1, person-mean centered) components.

To examine whether delays in the realization of intentions to work on study-related tasks can be predicted by within-person changes in task-specific appraisals (at Level 1), indicators quantifying these changes were needed. Therefore, assessments of task value, aversiveness, and effort measured at T1 were standardized using the grand-mean and standard deviation of the T0 measurements before subtracting the standardized T0 measurements from these standardized T1 measurements. In doing so, we receive a variable that represents changes in task value, task aversiveness, and effort evaluations between the task-specific measurements (changes from T0 to T1). These indicators were not centered at the person-mean to facilitate the interpretation of their effects by keeping a meaningful zero point (see Enders and Tofighi, 2007), which indicates that the appraisal of a task did not change between the two measurements. Finally, the TPS (trait procrastination) and the APSI-p (state procrastination) score was calculated for each participant to quantify individual differences in procrastination tendencies at baseline. The resulting variables were z-standardized and used as between-level predictors in the logistic two-level regression analyses.

A stepwise approach was used to predict the risk for the occurrence of task-specific delays, considering the impact of multiple predictors in eight logistic multilevel regression models. The outcome variable of interest is the binary indicator for whether a student reported to work on a task ($Y = 0$) or to delay working on that task ($Y = 1$). All models were computed using full information maximum likelihood estimation (MLR, maximum likelihood estimation with robust standard errors), random-intercepts[5], but fixed effects for predictor variables at the level of task-specific measurements (Level 1). The null model (intercept-only model) was computed to predict the average risk (logit of odds) for delays when none of the assessed predictors was included. To test our first Hypothesis, four logistic two-level regression models were analyzed (Model 1 through Model 4), including each of the task-specific appraisal dimensions (task value, task aversiveness, effort, and expectation of success) separately. To test the effects of the initial task-specific appraisals, the within-level components of T0 measurements were entered as predictors at Level 1. To test the effects of within-person changes in task-specific appraisals (task value, task, aversiveness, and effort), change indicators were entered as predictors at Level 1. Task-specific expectations of success were measured at T0 exclusively, so that there was only one predictor variable (i.e., the person-mean centered T0 assessment) included at Level 1 (i.e., Model 4). Finally, the person-mean (across tasks) of each predictor variable was included as a Level 2 covariate in each model to control for differences in students' average appraisals of their study-related tasks (e.g., some students may consistently score higher in their appraisal of task value than others). Two additional models were analyzed to examine the effects of between-person differences (at the level of students, Level 2) in baseline measures of trait-procrastination (TPS, Model 5) and state-procrastination (APSI-p, Model 6) on the risk that students delayed (vs. worked on) their tasks.

Our second hypothesis was tested in a combined analysis (Model 7), including all predictor variables reflecting students' subjective appraisals of tasks. Finally, to test our third hypothesis, we added the baseline measures of trait-procrastination (TPS) and state-procrastination (APSI-p) as predictors to the between-person level (Level 2) of the combined model (Model 8). This final step in the analysis was necessary to determine whether the predictive influence of task-specific appraisals and momentary changes in these appraisals (i.e., the within-person effects of task-specific determinants) on the risk that a task was delayed (vs. worked on) would persist when accounting for individual differences in general procrastination tendencies. The model fit for each model was compared against the null model – Model 8 was compared against Model 7 – using chi-square difference tests based on log-likelihood values and scaling correction (Satorra and Bentler, 2010; Muthén and Muthén, 2018).

RESULTS

Descriptives

There was no significant difference in general procrastination tendencies [TPS, $t(72) = 0.21$, $p = 0.83$; APSI-p, $t(72) = 0.31$; $p = 0.76$] between students that participated during winter or summer term (Winter: $M_{TPS} = 56.41$, $SD_{TPS} = 8.57$; $M_{APSI\text{-}p} = 1.92$, $SD_{APSI\text{-}p} = 0.57$; Summer: $M_{TPS} = 57.16$, $SD_{TPS} = 8.83$; $M_{APSI\text{-}p} = 1.88$, $SD_{APSI\text{-}p} = 0.67$).

On average, each student completed both task-specific measurements for 6.68 tasks using the e-diary. **Table 1** provides descriptive statistics for the task-specific assessments (task value, task aversiveness, effort, and expectation of success) before standardization or person-mean centering. **Table 2** provides descriptive statistics for the standardized between-level components (person-means at Level 2) and the within-level components (person-mean centered at Level 1) of each task-specific appraisal dimension (task value, task aversiveness, effort, and expectations of success) that was assessed during intention-formation (T0). **Table 2** also shows descriptive statistics for the variables that indicate within-person changes in the appraisals between T0 and T1 assessments (i.e., changes in task value, task aversiveness, and effort). Moreover, **Table 2** provides information on the units of increase that will support the interpretation of effects in the logistic two-level regression analyses.

With no predictor variables entered to the logistic two-level regression model (null model), the threshold risk for task-specific delays was $B = 2.093$ ($p < 0.001$). There was significant between-person variance in tasks being delayed vs. worked on ($s^2 = 3.217$; $p = 0.001$; 95% CI = 1.368; 5.066), indicating that 49% of the relative risk to delay (vs. work on) academic tasks was

[5]Mplus indicates thresholds (instead of intercepts) for logistic regression analyses. The threshold reflects the value (the probability expressed in the logit of odds) that must be reached or exceeded to observe the event.

TABLE 2 | Descriptive statistics for standardized variables (subjective task-specific appraisals) used as predictors in the logistic two-level regression analyses at Level 1 (task-specific ratings; $n = 501$) and Level 2 (person-mean ratings; $N = 75$ participants).

	Level 2			Level 1			
	M	*SD*	*Min; Max*	*M*	*SD*	*Min; Max*	units of increase[a]
Value (T0)	0.00	0.70	−2.24; 1.47	0.00	0.71	−3.24; 2.38	0.59
Value (T1–T0)	–	–	–	−0.13	0.86	−4.17; 4.35	0.59
Avers (T0)	0.00	0.67	−1.75; 2.05	0.00	0.75	−2.25; 2.32	0.57
Avers (T1–T0)	–	–	–	0.00	0.89	−5.25; 2.51	0.57
Effort (T0)	0.00	0.65	−1.72; 1.71	0.00	0.76	−3.50; 2.32	0.54
Effort (T1–T0)	–	–	–	−0.07	0.81	−3.23; 3.66	0.54
Expect (T0)	0.00	0.64	−1.79; 1.51	0.00	0.77	−2.42; 2.85	0.53

Task-specific ratings have been divided by 10 before standardizing. Level 2: person-mean values of standardized T0 ratings; Level 1: person-mean centered values of standardized T0 ratings; time-dependent differences (change) in task-specific assessments (T1–T0) at Level 1 were not centered at the person mean. Value, task value; Avers, task aversiveness; Effort, effort required; Expect, expectation of success; T0, first task-specific measurement; T1, second task-specific measurement; T1–T0, change in task-specific ratings between measurements.

[a]*Value that equals to an increase of 10 points on the original scale.*

explained by between-person variance in students' delay patterns (ICC = 0.49)[6].

Predicting Behavioral Delay by Within-Person Change Mechanisms

Results of the first four models (Model 1 – Model 4) computed to determine the effects of within-person variability in task-specific appraisals (initial assessment and change indicator at Level 1) – controlling for differences in students' average appraisals of their study-related tasks (person-mean across tasks at Level 2) – on the relative risk that a task is being delayed (vs. worked on) are depicted in **Table 3**. Each of these models had a significantly better fit than the null model (**Table 4** provides model fit information).

Results of Model 1 show that the average risk that a task was delayed (vs. worked on) was $B = 2.278$ ($p < 0.001$) when all predictors covering task value assessments are zero.[7] The risk that a task was delayed (vs. worked on) decreases significantly with one unit increase in the initial (T0) assessment of task value ($B = -0.866$; $p = 0.003$; OR = 0.41).[8] Moreover, the risk that a task was delayed (vs. worked on) decreases significantly when the subjective value of the task increases by one unit, from T0 to T1 ($B = -0.951$; $p < 0.001$; OR = 0.39). Between-person differences in the initial task value assessments (person-mean across tasks at Level 2) had no significant effect on the risk that a task was delayed (vs. worked on).

Results of Model 2 show that the average risk that a task was delayed (vs. worked on) was $B = 2.225$ ($p < 0.001$) when all predictors representing task aversiveness are zero. The risk that a task was delayed (vs. worked on) increases significantly when the initial (T0) assessment of task aversiveness ($B = 0.691$; $p = 0.018$; OR = 2.00) increases by one unit. The risk that a task was delayed (vs. worked on) increases significantly when the subjective aversiveness of the task increases by one unit, from T0 to T1 ($B = 0.749$; $p = 0.004$). The relative risk of delaying a task compared to working as intended doubles when task aversiveness increases by one unit between intention formation and intention realization assessments (OR = 2.12). The risk that a task was delayed (vs. worked on) increases significantly for students whose task ambiguity appraisal (across tasks at Level 2) exceeded the sample's average ($B = 1.086$; $p = 0.005$).

Results of Model 3 show that the average risk that a task was delayed (vs. worked on) was $B = 2.089$ ($p < 0.001$) when all predictors representing the appraisal of effort were zero. Contrary to our expectations, neither the initial appraisal of the effort required for working on a task (T0 assessments) nor the change indicator contributed significantly to the prediction of tasks being delayed (vs. worked on). This also holds for between-person differences in students' average initial appraisal on the effort required for their tasks (person-mean across tasks at Level 2).

Results of Model 4 show that the average risk that a task was delayed (vs. worked on) was $B = 2.313$ ($p < 0.001$) when students' prospective expectations of success were zero. As expected, the risk for a task being delayed (vs. worked on) decreases significantly when task-specific expectations of success exceed the person's mean by one unit ($B = -1.013$; $p < 0.001$). Students with an average expectation of success (person-mean across tasks, Level 2) that exceeds the average of the sample have a significantly lower risk of delaying (vs. working on) their tasks ($B = -1.238$; $p = 0.019$). Results of Model 5 and Model 6 (see **Table 5**) show

[6]The Intraclass Correlation Coefficient (ICC) for a binary dependent variable can be computed using the formula $ICC = \sigma_u^2/\sigma_u^2 + (\pi^2/3)$, with σ_u^2 being the random intercept variance. As the Level 1 residual variance cannot be freely estimated; it is implicitly fixed to the standard logistic distribution variance $\pi^2/3$ (cf. Schoeneberger, 2016; Sommet and Morselli, 2017).

[7]The meaning of the predictor variables being zero depends on standardization and centering. The change index is zero when there is no change in the appraisal from T0 to T1. The assessment at T0 equals zero for a participants' average evaluation of task value at Level 1 (due to person-mean centering). The Level 2 covariate (person mean) equals zero at the grand mean for the respective appraisal dimension. This principle applies to all models.

[8]Regression coefficients (beta estimates) resulting from logistic regression represent the effect of the predictor on the log odds of the outcome [i.e., a task being delayed ($Y = 1$) vs. worked on ($Y = 0$) in a pairwise comparison] for a one-unit increase in the predictor variable. The odds ratio (OR) reflects the change in the likelihood that a task is delayed ($Y = 1$) vs. worked on ($Y = 0$) for each unit increase in the predictor. An OR < 1 indicates that the likelihood for the task being delayed is reduced when the predictor increases one unit. An OR > 1 indicates that the likelihood of the task being delayed increases when the predictor increases one unit.

TABLE 3 | Distinct multi-level-models predicting the risk to delay ($Y = 1$) vs. work on a task ($Y = 0$), based on initial task-specific assessments (T0) and change indicators (T1–T0).

		B (*SE*)	*p*	95% CI	OR	R^2 (*p*)
Model 1.						
Threshold		**2.278** (0.331)	<0.001	1.630; 2.926	–	
L1	Val_{T1-T0}	**−0.951** (0.197)	<0.001	−1.338; −0.564	0.386	**0.173** (0.007)
L1	$Val_{T0/pmc}$	**−0.866** (0.297)	0.003	−1.447; −0.285	0.412	
L2	$Val_{T0/pm}$	−0.542 (0.333)	0.103	−1.195; 0.111	–	0.051 (0.441)
Model 2.						
Threshold		**2.225** (0.357)	<0.001	1.525; 2.962	–	
L1	Ave_{T1-T0}	**0.749** (0.263)	0.004	0.234; 1.264	2.115	0.103 (0.114)
L1	$Ave_{T0/pmc}$	**0.691** (0.291)	0.018	0.120; 1.261	1.995	
L2	$Ave_{T0/pm}$	**1.086** (0.386)	0.005	0.329; 1.843	–	0.178 (0.091)
Model 3.						
Threshold		**2.089** (0.339)	<0.001	1.425; 2.753	–	
L1	Eff_{T1-T0}	0.201 (0.273)	0.461	−0.334; 0.737	1.223	**0.020** (0.419)
L1	$Eff_{T0/pmc}$	0.361 (0.214)	0.092	−0.059; 0.781	1.435	
L2	$Eff_{T0/pm}$	0.075 (0.425)	0.860	−0.757; 0.907	–	0.001 (0.929)
Model 4.						
Threshold		**2.313** (0.367)	<0.001	1.594; 3.032	–	
L1	$Exp_{T0/pmc}$	**−1.013** (0.248)	<0.001	−1.499; −0.527	0.363	**0.156** (0.017)
L2	$Exp_{T0/pm}$	**−1.238** (0.526)	0.019	−2.269; −0.206	–	0.154 (0.210)

*L1, Level 1 (n = 501 tasks); L2, Level 2 (N = 75 participants); B, regression coefficient (log odds); CI, confidence interval; OR, odds ratio; Threshold, random parameter; Val, task-value; Ave, task aversiveness; Eff, effort required; Exp, expectation of success; T1–T0, change-parameter (difference between task-specific measurements); T0/pmc, within-level parameter for the first measurement (T0) centered at the person mean (pmc); T0/pm, between-level parameter, person mean (pm) of the first measurement **(T0)**. Significant estimates printed in bold.*

that the average risk that tasks were delayed (vs. worked on) was not significantly affected by students' baseline procrastination tendencies (TPS and APSI-p).

To test our second hypothesis, all predictors were entered into the combined model (Model 7). The combined model had a significantly better fit than the null model (see **Table 4**). The threshold indicates that the average risk that a task was delayed (vs. worked on) was $B = 2.486$ ($p < 0.001$) when all predictors are zero. Initial task value and task aversiveness appraisals (T0 assessments) lose their predictive power in the combined analysis (see **Table 6**). However, the risk to delay (vs. work on a task) was affected by students' task-specific expectations of success (T0 assessments), even in the combined model (see **Table 6**). Moreover, in accordance with the separate analyses, results of the combined model revealed that the risk to delay (vs. work on a task) was significantly related to task-specific within-person changes in students' value ($B = -0.821$; $p < 0.001$) and task aversiveness ($B = 0.588$; $p = 0.021$) appraisals. None of the remaining indicators for task-specific appraisals reached significance in this model, which also applies to the Level 2 covariates. Overall, the results of Model 7 revealed that task-specific within-person effects explained 30% of the variance ($R^2 = 0.299$, $p < 0.001$), whereas between-person differences have not significantly contributed to the explanation of variance ($R^2 = 0.243$, $p = 0.081$) in students' task-specific delay behavior.

Finally, to test our third hypothesis, the baseline measures for trait-procrastination (TPS) and state-procrastination (APSI-p) were added to the between-person level of the model (Model 8). Model 8 had a significantly better fit than Model 7 (see **Table 4**). The results obtained from Model 8 show that measures of individual differences in procrastination tendencies (TPS and APSI-p assessed at baseline) do not predict differences in students' task-specific delay behavior in real-life academic situations (detailed results depicted in **Table 6**). However, the risk to delay (vs. work on a task) was substantially affected by students' initial task-specific expectations of success and by within-person changes in their task value and aversiveness appraisals (see Model 8, **Table 4**).

DISCUSSION

Although it has been frequently suggested that procrastination results from the failure of self-regulatory mechanisms (e.g., Dewitte and Lens, 2000; Wolters, 2003; Steel and König, 2006; Howell and Watson, 2007; Sirois and Pychyl, 2013), most previous studies neglected that this assumption cannot be comprehensively tested based on the cross-sectional examination of between-person differences. The present study addressed this problem by using an event-based experience-sampling approach to investigate whether the occurrence of task-specific delay behavior can be attributed to failures in self-regulation, which

TABLE 4 | Model fit information for the six distinct and two combined logistic multi-level models predicting the risk to delay ($Y = 1$) vs. work on a task ($Y = 0$).

Model	AIC	BIC (n-adjusted)	Chi-square difference test[a]
Null Model	452.64	454.73	–
Model 1	421.13	426.34	TRd = 609.49 > χ^2 (3) = 11.35; $p < 0.001$
Model 2	435.57	440.79	TRd = 701.19 > χ^2 (3) = 11.35; $p < 0.001$
Model 3	455.12	460.33	TRd = 625.46 > χ^2 (3) = 11.35; $p < 0.001$
Model 4	412.54	416.71	TRd = 569.50 > χ^2 (2) = 13.82; $p < 0.001$
Model 5	445.33	448.44	TRd = 742.33 > χ^2 (1) = 6.63; $p < 0.001$
Model 6	446.71	449.81	TRd = 960.84 > χ^2 (1) = 6.63; $p < 0.001$
Model 7	400.11	413.66	TRd = 735.00 > χ^2 (11) = 24.73; $p < 0.001$
Model 8	396.61	412.13	TRd = 10.74 > χ^2 (2) = 9.21; $p < 0.001$

Chi-square difference tests showed the relative superiority to the null model, based on log-likelihood values and scaling correction factors, using Satorra-Bentler test statistic (Satorra and Bentler, 2010; Muthén and Muthén, 2018), Model 8 was tested against Model 7. Two within-level and one between-level predictor for task value (Model 1), task aversiveness (Model 2), and the effort required for working on a task (Model 3); one within-level and one between-level predictor for task-specific expectations of success (Model 4); Models 5 and 6 each included one between-level predictor (TPS; APSI-p). Predictors included in Model 1 through 4 were combined in Model 7; Model 8 included all predictors included in Model 1 through 6. [a]*, followed by "all p < 0.001."*

are expressed by unfavorable task-specific appraisal mechanisms, evolving between critical phases of goal-directed action. Overall, our study results show that their tasks' subjective momentary appraisal predicted student's dilatory behavior. Moreover, the findings supported our theoretical prediction that within-person changes in the subjective momentary appraisals of study-related tasks evolving between critical stages of goal-directed action predicted the occurrence of dilatory behavior in real-life academic settings. Between-person differences in general procrastination tendencies have not significantly contributed to the prediction of students' delay behavior patterns.

Task-Specific Determinants of Delay Behavior: The Initial Appraisal of a Task

In line with our first hypothesis, task-specific within-person differences in students' expectations of success, task value, and task aversiveness assessed during intention formation predicted the occurrence of delays when the different appraisal dimensions were examined independently. These findings suggest that students tend to delay working on those tasks for which they see lower chances of success, to which they attach lower value (or lower personal importance), and which they perceive as particularly aversive compared to their average task-specific evaluations.

Our results correspond to the findings of previous studies, which indicate that students who have less confidence in their ability to complete academic tasks successfully procrastinate more frequently than those who have stronger competency or self-efficacy beliefs (e.g., Ferrari et al., 1992; Lay, 1992; Wolters, 2003; Wäschle et al., 2014). Moreover, our findings provide further evidence that the expectancy of being able to accomplish the task successfully protects students from delaying goal-directed learning behavior (Wäschle et al., 2014). However, to our knowledge, the present study is the first to demonstrate a direct relationship between student's task-specific efficacy beliefs (i.e., expectations) and the occurrence of task-specific delay behavior in real-life academic settings.

The influence of the personal value attributed to the achievement of academic tasks has received surprisingly little attention in previous studies on potential determinants of procrastination. This is particularly astonishing because task value is explicitly emphasized in theoretical explanations of the origins of dilatory behavior (e.g., Steel and König, 2006; Glick and Orsillo, 2015; Steel and Weinhardt, 2018). In line with theoretical assumptions, our study revealed that tasks to which students initially attributed an above-average value were significantly less likely to be delayed. This suggests that the occurrence of dilatory behavior might be prevented if students perceive the accomplishment of tasks as personally valuable (or useful; cf. Wäschle et al., 2014). Moreover, in conjunction with the moderately strong, positive correlations between value appraisals and expectations of success (within-level correlations), it seems plausible that the protective effects of above-average ratings on both of these dimensions can be at least partially attributed to the existence of stronger goal commitments (Hollenbeck and Klein, 1987; Gollwitzer, 1993; Klein et al., 1999; Wieber and Gollwitzer, 2010). This is also consistent with findings by Dietrich et al. (2017), indicating that students invested more effort in learning in a given situation if they attached above-average expectations or values to the respective task or topic. In summary, our findings substantiate those of previous studies and indicate that a lack of commitment (or motivation, Locke et al., 1988; Locke and Latham, 1990) increases the risk to delay one's task-specific action contrary to one's original intention.

The finding that tasks initially perceived as particularly aversive were more likely to be delayed is consistent with the results of previous studies using diaries (Ferrari and Scher, 2000) or experience sampling with pagers (Pychyl et al., 2000). Cross-sectional research has also revealed that students report procrastinating more frequently when faced with typical academic tasks that are perceived as exceptionally aversive, unpleasant, or unenjoyable (e.g., Milgram et al., 1988, 1995; Lay, 1992). Based on these findings, procrastination behavior has been explained as an impulsive avoidance response to an

TABLE 5 | Multi-level-models predicting the risk to delay ($Y = 1$) vs. work on a task ($Y = 0$), based on individual differences in trait- and state-procrastination tendencies.

	B (*SE*)	*p*	95% CI	R^2 (*p*)
Model 5.				
Threshold	2.148 (0.348)	<0.001	1.466; 2.831	
TPS	0.324 (0.311)	0.299	−0.287; 0.934	0.030 (0.591)
Model 6.				
Threshold	2.140 (0.346)	<0.001	1.462; 2.819	
APSIp	−0.026 (0.268)	0.923	−0.550; 0.499	0.000 (0.962)

Predictors are between-level variables (Level 2), N = 74 participants. B, regression coefficient (log odds); CI, confidence interval; OR, odds ratio; TPS, Tuckman Procrastination Scale (baseline measure); APSIp, Academic Procrastination State Inventory (baseline measure).

TABLE 6 | Combined multi-level-models predicting the risk to delay ($Y = 1$) vs. work on a task ($Y = 0$), based on initial task-specific assessments (T0) and change indicators (T1–T0).

	Model 7[a]				Model 8[b]	
	***B* (*SE*)**	***p***	**95% CI**	**OR**	***B* (*SE*)**	***p***
Threshold	**2.486** (0.362)	<0.001	1.776; 3.197	–	**2.537** (0.358)	<0.001
L1. Val_{T1-T0}	−**0.821** (0.212)	<0.001	−1.236; −0.405	0.440	−**0.824** (0.212)	<0.001
L1. Ave_{T1-T0}	**0.588** (0.254)	0.021	0.089; 1.086	1.800	**0.583** (0.253)	0.021
L1. Eff_{T1-T0}	−0.060 (0.259)	0.817	−0.567; 0.447	0.942	−0.003 (0.259)	0.990
L1. $Val_{T0/pmc}$	−0.570 (0.302)	0.059	−1.162; 0.022	0.566	−0.597 (0.307)	0.052
L1. $Ave_{T0/pmc}$	0.375 (0.262)	0.152	−0.138; 0.888	1.455	0.307 (0.253)	0.226
L1. $Eff_{T0/pmc}$	0.325 (0.214)	0.128	−0.094; 0.743	1.384	0.339 (0.213)	0.112
L1. $Exp_{T0/pmc}$	−**0.726** (0.271)	0.007	−1.258; −0.194	0.484	−**0.685** (0.271)	0.011
L2. $Val_{T0/pm}$	−0.244 (0.398)	0.540	−1.023; 0.536	–	−0.491 (0.379)	0.195
L2. $Ave_{T0/pm}$	0.880 (0.468)	0.141	−0.229; 1.605	–	0.482 (0.453)	0.288
L2. $Eff_{T0/pm}$	−0.034 (0.495)	0.945	−1.003; 0.936	–	0.065 (0.484)	0.892
L2. $Exp_{T0/pm}$	−0.830 (0.605)	0.170	−2.015; 0.355	–	−0.902 (0.617)	0.144
L2. TPS_{bl}	–	–	–	–	0.397 (0.147)	0.274
L2. $APSIp_{bl}$	–	–	–	–	−0.185 (0.462)	0.252

B, regression coefficient (log odds); CI, confidence interval; OR, odds ratio; Threshold, random parameter; L1, Level 1; L2, Level 2; Val, task value; Ave, task aversiveness; Eff, effort required for task; Exp, expectation of success; T1–T0, change parameter [difference between second (T1) and first measurement (T0)]; T0/pmc, within-level parameter of the first measurement (T0) centered at the person mean (pmc); T0/pm, between-level parameter, person mean (pm) of the first measurement (T0); TPS_{bl}, Tuckman Procrastination Scale; $APSIp_{bl}$, Academic Procrastination State Inventory. Significant estimates printed in bold.

[a] $n_{L1} = 501$ *tasks,* $R_{L1}^2 = 0.299$ *(*$p < 0.001$*);* $N_{L2} = 75$ *participants,* $R_{L2}^2 = 0.243$ *(*$p = 0.081$*).*

[b] $n_{L1} = 497$ *tasks,* $R_{L1}^2 = 0.290$ *(*$p < 0.001$*);* $N_{L2} = 74$ *participants,* $R_{L2}^2 = 0.283$ *(*$p = 0.054$*).*

(affectively) negative experience that occurs when facing a task that cannot be aligned with one's present needs or appears to exceed one's current resources and abilities (Flett et al., 1995; Blunt and Pychyl, 2000; Tice et al., 2001; Sirois and Pychyl, 2013). This proposition has been further supported by empirical findings that link pronounced procrastination tendencies with an increased experience of or intolerance toward negative emotions and with the inability to adequately regulate these emotions (e.g., McCown et al., 2012; Rebetez et al., 2015; Eckert et al., 2016; Pollack and Herres, 2020). Blunt and Pychyl (2000) have further examined the meaning of students' task aversiveness perceptions across different stages of goal pursuit. Their findings revealed, among other things, that tasks that were postponed because they were perceived as being aversive were also frequently experienced as being frustrating or boring. According to Pekrun's control-value theory of achievement emotions (Pekrun, 2006; Pekrun et al., 2007)[9], feelings of frustration and boredom depend on perceptions of control over the outcome of an achievement-related activity and on the value attached to that outcome. Frustration should arise when a student appraises the outcome of an achievement-related activity as being valuable but has the expectancy of lacking control over achieving this outcome (Pekrun, 2006). Feelings of boredom should arise when students do not ascribe enough value to the outcome of an achievement-related activity, which may be due to a lack of control over the outcome or to task demands falling far below students' abilities (Pekrun et al., 2007). While we cannot say whether students evaluated a task as being particularly aversive because they anticipated that the task-specific activity might frustrate or bore them, based on the results of the present study. We would like to suggest that future studies might take this possibility into account.

In contrast to previous studies, where students' preference for avoiding effort was associated with elevated procrastination tendencies (e.g., Ferrari and Scher, 2000; Wolters, 2003; Howell and Watson, 2007), our results did not reveal that the effort expected for performing a task predicted the occurrence of task-specific delay behavior. However, the results show that the effort that was anticipated as being required for task accomplishment was most strongly related to students' appraisals of task aversiveness (within-person). The present study results likely differ from previous findings because we did not focus on students' general procrastination tendencies but rather on their self-reported, momentary, and task-specific delay behavior. The effort required to accomplish a task may have an impact on the occurrence of delays only in the long term (in distal goal striving) when the person's resources are gradually depleted (Baumeister et al., 2000; Muraven and Baumeister, 2000; Inzlicht and Schmeichel, 2012). Thus, our focus on proximal, task-specific behavioral intentions may have led to a situation in which the effort required to accomplish the tasks was rather small. However, students' ratings for task-specific effort did not differ substantially in range compared to the other appraisal dimensions.

Although not very strong, we did find a positive relationship between task-specific value and effort appraisals at the within-person level. This suggests that students do not necessarily experience task-specific effort costs as being negative. Based on their empirical analysis of different cost

[9]It should be noted that Pekrun (2006) theory is generally in line with the basic proposition of appraisal theories, that the appraisal of the situation informs or defines the individual's emotional response (cf. Frijda et al., 1989; Lazarus, 1993; Ellsworth and Scherer, 2003; Gross, 2015).

components (including the costs associated with the "loss of valued alternatives" and the "outside effort costs" associated with other activities), Flake et al. (2015) argued that considering different cost components is important for improving our understanding of what motivates or constrains students' engagement in a subject (or task). Thus, it is possible that the task-specific effort costs that have been addressed in the present study do not cover the cost components that are related to the occurrence of task-specific delay behavior. The examination of costs connected with the loss of valued alternatives may be one promising area for research that could contribute significantly to understanding the onset of procrastination behavior.

Task-Specific Determinants of Delay Behavior: Effects of Within-Person Change

Whereas students' prospective expectations of success consistently predicted the risk for behavioral delays, initial appraisals of task value and task aversiveness lost their predictive power as soon as the different appraisal dimensions were examined together in a combined multivariate analysis. Instead, and corresponding to our second hypothesis, momentary (time-dependent) within-person changes in students' task-specific value and aversiveness appraisals predicted the occurrence of dilatory behavior consistently. Specifically, the results of the combined models revealed that the risk to delay the accomplishment of a task decreased when the task's value increased between the two task-specific measurements. The risk of a delay increased with an increase in the perceived aversiveness between the intention formation and the moment that the intention was to be realized. Overall, these results suggest that behavioral delays were much more likely to occur when students devalued their tasks compared to their initial evaluation. Vice-versa, the risk of delaying goal-directed actions decreased in cases where students succeeded in maintaining a positive attitude toward the task. Thus, if a delay occurred at the time scheduled for realizing their intention, students apparently did not apply effective strategies – including (meta-)cognitive as well as emotion-regulation strategies – to maintain a positive attitude toward their task. Therewith, our findings are in line with the idea that inadequate self-regulation contributed to the occurrence of dilatory behavior (e.g., Dewitte and Schouwenburg, 2002; Steel and König, 2006; Sirois and Pychyl, 2013; Steel et al., 2018).

Previous cross-sectional studies revealed that students who lack abilities to self-regulate their learning behavior are generally more inclined to procrastinate on their study-related tasks (e.g., Wolters, 2003; Howell and Watson, 2007; Klassen et al., 2008; Corkin et al., 2011). However, self-regulated learning is conceptualized as an intra-individual, task- and context-specific process (e.g., Winne and Hadwin, 1998; Zimmerman, 2002; Pintrich, 2004; Inzlicht et al., 2014). These processes cannot be illustrated by cross-sectional sampling plans but should be investigated within more extensive longitudinal research designs (e.g., Schmitz, 2006). With their longitudinal study, Wäschle et al. (2014) provided a good example. Their results show that students use more cognitive strategies to self-regulate their learning and reduce procrastination if they consider the respective learning goal personally valuable (Wäschle et al., 2014). This also supports the interpretation that the present results reflect the proximate intra-individual (time-dependent, within-person) association between self-regulatory failures and the occurrence of task-specific delay behavior in real-life academic settings.

Although our results provide evidence that the occurrence of delay behavior was associated with a momentary devaluation of the task, we cannot draw conclusions about why students' initial task-specific appraisals have changed. Following the assumptions of Temporal Motivation Theory (TMT; Steel and König, 2006; Steel and Weinhardt, 2018), it is quite possible that the devaluation of a task resulted from a direct comparison with a potentially more attractive alternative activity. However, the present investigation was not supposed to and cannot provide evidence for the temporal discounting principle proposed in TMT (Steel and König, 2006; Ainslie, 2012), as no comparison with an alternative activity was made.

In the present study, task-specific appraisals provided when the intention was formed were used as a reference for the comparison with those provided when the intention was to be realized. Thereby, the present study has demonstrated that intra-individual devaluation processes are involved when students delay the accomplishment of their tasks. These findings are in line with the theory that procrastination behavior is an impulsive avoidance response to (affectively) negative experiences that occur when an individual has to deal with a task (Sirois and Pychyl, 2013). This proposition has been previously supported by studies that related students' procrastination tendencies to more pronounced experiences of negative emotions or the inability to regulate these emotions adequately (e.g., McCown et al., 2012; Rebetez et al., 2015; Eckert et al., 2016; Pollack and Herres, 2020). However, insight into the dynamic processes that affect procrastination behavior under everyday conditions is only possible if situational and task-specific influences are examined in addition to person-level determinants. Some seminal research has pursued this direction in the last two decades (e.g., Pychyl et al., 2000; Moon and Illingworth, 2005; Steel et al., 2018; van Eerde and Venus, 2018; Pollack and Herres, 2020). One of the findings of these studies is that an increased occurrence of procrastination behavior was related to everyday stresses (such as negative affect, Pollack and Herres, 2020; or poor sleep quality, van Eerde and Venus, 2018), providing additional support for the theoretical propositions of the mood-repair hypothesis (Sirois and Pychyl, 2013). The sophisticated experience sampling approach used in the present study helped to contribute and refine previous findings on the relationship between the affective experience of task aversiveness and the occurrence of task-specific delay behavior. Particularly noteworthy is the finding that the short-term increase in the appraisal of task aversiveness – at the moment when the intention was meant to be realized –

significantly increased the risk for the occurrence of a delay. While we have not included any additional measures of students' affective reactions to their tasks in the present study (besides asking about perceptions of aversiveness), we would like to advocate that future studies continue to test the assumptions of the mood-repair hypothesis (Sirois and Pychyl, 2013) by using very carefully planned sampling designs to contribute to a better understanding of the within-person processes that affect the occurrence of procrastination behavior under real-life conditions.

The Impact of Between-Person Differences

The separate analyses revealed that delays were more likely to occur for students whose average task aversiveness appraisal in the initial intention formation exceeded the sample's average by at least one standard deviation. This suggests that students who generally feel that their study-related tasks are highly aversive are more likely to delay working on their tasks. This finding corresponds with previous studies (e.g., Lay, 1992; Blunt and Pychyl, 2000; Ferrari and Scher, 2000; Pychyl et al., 2000). Under separate analysis, delays were significantly less likely to occur for students whose average expectations of success exceeded the sample's average. Again, this is in line with previous research suggesting that students with stronger competency or self-efficacy beliefs are less likely to procrastinate than those who are less confident about their achievement potential (e.g., Wolters, 2003; Wäschle et al., 2014). However, there was no effect of students' initial average evaluation for task aversiveness or their average expectation of success on the occurrence of behavioral delays in the combined analyses. Moreover, there was no effect of individual differences in students' initial task-specific value appraisals on their delay behavior. Thus, our results do not suggest that some students are more likely to delay their study-related tasks because they have lower expectations of success in general. Likewise, it is not that behavioral delays become more or less likely because some students tend to assign higher personal value to their study-related tasks or experience all their tasks as more aversive than other students.

Instead, our results point to the fact that momentary within-person changes in the cognitive-affective appraisals of their tasks were the primary determinants of students' delay behavior. In line with theoretical presumptions about the self-regulation of learning behavior (e.g., Winne and Hadwin, 1998; Boekaerts, 1999; Zimmerman, 2002; Pintrich, 2004), our findings suggest that students' behavior is indeed strongly affected by the cognitive-affective appraisal of the task, which can change over time according to the prevailing situational or contextual conditions. It follows that the study of between-person differences should be complemented by studies clarifying more specifically which intra-individual (cognitive-affective) processes need to be effectively regulated by students in order to avoid delays in fulfilling their study-related tasks.

In the present study, individual differences in students' self-reported general procrastination tendencies (measured by established questionnaires at baseline) did not predict their average risk for everyday dilatory behavior. In previous studies (e.g., Steel et al., 2001; Dewitte and Schouwenburg, 2002; Moon and Illingworth, 2005; Krause and Freund, 2014), procrastination tendencies measured by self-report questionnaires were weakly, or at best moderately correlated with observed behavioral delays (e.g., time until taking a test or handing in homework, or differences between the planned vs. actual time spent on learning activities). By showing that neither students' general trait-based procrastination tendency nor their last week's self-reported procrastination tendencies predicted their momentary task-specific procrastination behavior, our results are generally in line with findings suggesting that a merely trait-based explanation may not adequately describe the complex mechanisms involved in the occurrence of procrastination behavior (e.g., Steel et al., 2001; Moon and Illingworth, 2005). However, such a conclusion should be further substantiated by carefully designed studies and on the basis of a larger sample size (i.e., individuals at Level 2). In this connection, it should also be considered that the few longitudinal studies available have used distinct measures for both trait-procrastination and delay behavior, making it difficult to determine whether specific self-report questionnaires might be more or less suitable for predicting students' actual delay behavior. We have therefore applied two different self-report questionnaires, one to assess students' general procrastination tendency and one to assess students' more proximal tendency to procrastinate on learning activities during the past week. Thus, it appears that it was not the different time- or content-specificity of the questionnaires used to capture students' procrastination tendencies accounting for this lack of correlation with students' self-reported actual delay behavior. Finally, it should be considered that the type of tasks students indicated in the e-diary may also have contributed to the fact that we found no strong effect of procrastination tendencies on the individual delay behavior reported in the e-diary. The short free-text inputs that students used to document their tasks were not very specific or elaborated. The entries consisted of single keywords (e.g., "complete worksheet," or "tutorial"), which were visually checked for meaningfulness, but not qualitatively analyzed. This possibility would certainly be an informative endeavor that should be considered in future research.

Implications for Research and Practice

The present work adds to an emerging effort to understand the within-person processes that affect students' procrastination behavior over time and within their natural learning environment. The present study cannot provide direct evidence for causality in the relationship between within-person changes in students' task-specific appraisals and the occurrence of behavioral delays. However, our study goes beyond the mere observation of delays in behavioral outcomes and the examination of individual differences in students' procrastination tendencies, ensuring that both the occurrence of behavioral delays and the behavioral determinants were captured

both in real-time and within real-life academic settings. The results highlight the importance of gaining a deeper insight into the dynamic processes that determine success or failure in students' efforts to realize their task-specific intentions. It is reasonable to assume that the detrimental changes in the task-specific appraisals that have been revealed in the present study may be more frequently experienced by more impulsive students who are less skilled in self-regulation (Steel, 2007), more intolerant toward the experience of negative emotions (e.g., Harrington, 2005), or less skilled in regulating the experience of negative emotions (e.g., Rebetez et al., 2015; Eckert et al., 2016). However, provided that procrastination behavior has been explained to arise because the avoidance of the negative affective experience that arises when dealing with a task that is perceived as aversive is prioritized over the benefit of long-term goal pursuit (Sirois and Pychyl, 2013), it is imperative to examine the momentary within-person processes that are involved. It is therefore essential that future studies continue and intensify previous efforts to use the far-reaching possibilities of intensive longitudinal assessments to gain a better understanding of the within-person processes that determine the success or failure of students' self-regulatory efforts and influence their actual behavior in everyday academic life.

Knowledge of these processes will also benefit the development of learning environments that support self-regulated learning processes. Students who procrastinate frequently will certainly benefit from many of the already existing cognitive-behavioral interventions (see e.g., Schouwenburg et al., 2004; van Eerde and Klingsieck, 2018). However, the present findings suggest that approaches and interventions can be helpful, focusing less on changing the students than changing the instructional context and the tasks assigned to students. First, our result suggest that it can be helpful to strengthen students' commitment to their study-related tasks and to support them to perceive their academic tasks as personally valuable (or relevant). Teachers should emphasize what students should learn by the tasks and how they can use this knowledge in later fields of application. This also entails setting tasks of practical relevance. Second, in order to support students' expectations of success, it might be helpful if teachers express task requirements more explicitly, state what is expected, and by which criteria students' performance is assessed. The importance of strengthening students' efficacy expectations was also emphasized in previous research (e.g., Wolters, 2003; Wäschle et al., 2014). Wäschle et al. (2014) demonstrating that higher perceived self-efficacy to master study-related tasks protects against the occurrence of procrastination behavior and can be further enhanced by the experience of success. Setting adequate learning goals could contribute not only to strengthening students' expectations of being effective in achieving their tasks but also to minimize their risk for behavioral delay (cf. Wolters, 2003; Wäschle et al., 2014).

Furthermore, the present findings emphasize the relevance of being equipped with effective self-regulation strategies and to apply them to work against the devaluation of a task. It has been previously demonstrated that trainings focusing on the ability to tolerate negative emotions can prevent the frequent occurrence of procrastination behavior (cf. Eckert et al., 2016). The finding that an increase in the aversiveness of a task at the moment when the intention to act was to be realized increases the risk to procrastinate further stresses the importance for students (at least for those with pronounced procrastination tendencies) to be trained in dealing with the experience of negative emotions. At the same time, it remains to be further clarified what contributes to students perceiving their academic tasks to be particularly aversive. Following Pekrun's control-value theory of achievement emotions (Pekrun, 2006; Pekrun et al., 2007), a spontaneous increase in the perceived task aversiveness could indicate both students' feeling bored in dealing with the task or that they feel overwhelmed. Both would suggest that moderately challenging tasks tailored to students' abilities could reduce the risk for behavioral delays. Although this is a proposal to be backed up by future research, it is in line with Ferrari and Scher's (2000) conclusion that tasks should be challenging but still enjoyable to increase the likelihood that students will perform them.

Limitations

Some limitations of the present study should be taken into account, as they can also provide helpful information for future investigations. The first limitation refers to the possibility that our results may have been influenced by students' reactivity to the e-diary. We tried to minimize potential biases due to social desirability effects by not explicitly asking students about their "procrastination" in the e-diary, but it is well possible that using the e-diary to evaluate their tasks and report their behavior regularly increased self-reflection (e.g., Barta et al., 2012; Conner and Reid, 2012) and thereby reduced the number of tasks that have been delayed. Moreover, the event-based experience sampling approach might itself serve as an intervention affecting the results. The instruction to state intentions about when one would like to work on a certain task the next day is similar to setting implementation intentions (Gollwitzer, 1999), which can be an effective strategy to prevent procrastination (e.g., Gollwitzer and Sheeran, 2006; Wieber and Gollwitzer, 2010), although there is also evidence that implementation intentions alone may be insufficient to prevent the occurrence of procrastination behavior or the occurrence of intention-behavior gaps (e.g., Cooke and Sheeran, 2004; Gustavson and Miyake, 2017). Moreover, the short free-text inputs that students used to document their tasks were not very specific or elaborated. The entries consisted of single keywords. Finally, if students would have delayed more of their tasks without using the e-diary, we might have even underestimated the effects of students' task-specific appraisals on their delay behavior in the present study.

The second limitation refers to potential selectivity effects. Students participating in the present study were enrolled in cross-curricular courses advertised to help students self-organize their learning. We cannot rule out the possibility that self-selectivity effects may have affected the results, although the data analyzed to answer our research questions have

been captured before any time-management or self-regulation strategies have been addressed. It is possible that students enrolled in the courses were highly motivated to change their behavior and have therefore procrastinated less, which should be considered as a major limitation when interpreting the results of our study. Although a comparison of our sample's average scores with other (representative) student samples (e.g., Stöber, 1995; Helmke and Schrader, 2000) has shown that these were comparable in their average procrastination tendencies, it would be desirable to replicate our findings in a more representative student sample. It should also be mentioned that the large proportion of male students in our sample was most likely due to the fact that the proportion of male students in more technically oriented disciplines is still larger than in other disciplines. Thus, the results of our study may not be representative for students of all disciplines, as for example, there is usually a higher proportion of female students enrolled in the humanities or social sciences. Finally, students may also have been selective in the choice of the task-specific intentions they indicated. We cannot rule out the possibility that selectivity effects occurred due to the tasks that students have chosen (sampling of events analyzed at Level 1). Future studies could control objective features of the learning goals, ensuring that all students have to fulfill the same task (e.g., studying for the same exam) but set their own proximal learning goals.

Fourth, it should be noted that the sample size analyzed was relatively small to uncover individual differences in students' procrastination behavior. According to the simulation study by Schoeneberger (2016), the sample size was sufficiently large to address our primary research question and provide reliable results. However, it cannot be ruled out that the finding that between-person differences in procrastination tendencies (captured by questionnaire measures) were not significantly related to individuals' risk for delaying their tasks was a type two error. This finding should therefore be re-examined in studies with larger samples.

Fifth, the items used in the e-diary (presented in English and German in the Appendix) have not completely covered all facets of the respective constructs. The selection of items was theoretically justified, but it was necessary to keep the number of items as small as possible when implementing the study. It can be assumed, for example, that the wording of the item used to measure students' task value appraisals might not properly differentiate between the relevant components of "personal importance" and "attainment value" (cf. Trautwein et al., 2012; Dietrich et al., 2019). To address this limitation appropriately, future studies using a similar design should therefore focus on capturing individual appraisal dimensions in more detail.

Sixth, we want to mention the limitation that we cannot say what caused the within-person changes in students' task-specific appraisals predicting behavioral delay. We do not know whether some defensive mechanism caused the devaluation of a task (e.g., Knaus, 2000; Tuckman, 2005) to protect the self from the harmful recognition that one failed to follow one's intention. It could be equally true that situational circumstances cause the devaluation. Future studies are needed to understand how task-specific cost-benefit considerations (cf. Flake et al., 2015) influence students' decisions to learn (or work on their tasks) as intended or delay learning by engaging in alternative activities. It might also be informative in future studies to investigate whether the effects that were found in the present study differ between tasks that are study-related and those tasks from other (non-study-related) areas of life that have not been further examined in the present study.

CONCLUSION

The present study examined the link between behavioral delays in goal-directed actions by focusing on momentary within-person changes in students' task-specific appraisals that may indicate a failure of self-regulation. Our findings support the view that the occurrence of delay behavior can be explained (in part) by within-person changes in cognitive-affective appraisals of tasks that appear between critical phases of goal pursuit. In contrast, students' average risk to delay working on study-related tasks was not predicted by their general procrastination tendencies in the present study. These findings call for taking new perspectives in both research and teaching. More attention should be paid to the fact that students' procrastination and learning behavior are determined by more than trait-based influences, attitudes, or abilities, but also by their perception of the task at hand and their affective experiences, which will both be considerably influenced by the context or situation. On the one hand, it is up to educators to ensure that students perceive the tasks assigned to them as a positive challenge, the accomplishment of which has practical, and thus personal, relevance. On the other hand, students will profit from trainings that strengthen their ability to effectively regulate their emotional reactions when dealing with aversive tasks. Finally, research must continue and increase the efforts to understand the (within-person) mechanisms that invoke self-regulated learning to fail and ultimately provoke students to delay working on their study-related tasks.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

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

LW was involved in conceptualization, data curation, formal analysis, investigation, methodology, project administration, software, validation, visualization, and writing – original draft. UE-P was involved in funding acquisition, project administration, resources, supervision, and writing – review and editing. ML was involved in data curation, project administration, software, and validation. UN was involved in funding acquisition, project administration, resources, supervision, and writing – review and editing. All authors contributed to the article and approved the submitted version.

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APPENDIX

The e-diary items used in this study were presented to the students in German language and have been translated into English for the purpose of presentation in this publication. Below, we list the items used to assess students' task appraisals in the original German wording and in the English translation. Each time, students were asked to indicate their appraisals, the respective task appeared on the screen, followed by the items:

Items used to assess students' task appraisal in the planning phase (T0).

Appraisal	German wording	English translation
Value	Wie wichtig ist es Ihnen persönlich, dass Sie diese Aufgabe morgen erledigen/dieses Tagesziel erreichen?	How important is it to you personally that you work on that task/reach that goal tomorrow?
Expectation	Wie schätzen Sie die Wahrscheinlichkeit ein, dass Sie diese Aufgabe morgen tatsächlich erledigen/dieses Tagesziel tatsächlich erreichen?	How likely do you think it is that you will work on that task/reach that goal tomorrow?
Aversiveness	Wie (un-)angenehm ist diese Aufgabe/die Bearbeitung dieses Tagesziels für Sie?	How (un-)pleasant is this task/working on this goal?
Effort	Wie viel Anstrengung müssen Sie voraussichtlich investieren um diese Aufgabe zu bearbeiten/dieses Tagesziel zu erreichen?	Prospectively, how much effort do you have to invest to work on this task/reach this goal?

Items used to assess students' task appraisal in the implementation phase (T1).

Appraisal	German wording	English translation
Value	Wie wichtig ist es Ihnen persönlich, dass Sie diese Aufgabe jetzt erledigen/dieses Tagesziel erreichen?	How important is it to you personally that you work on that task/reach that goal right now?
Aversiveness	Wie (un-)angenehm ist diese Aufgabe/die Bearbeitung dieses Tagesziels jetzt gerade für Sie?	How (un-)pleasant is this task/working on this goal right now?
Effort	Wie viel Anstrengung müssen Sie jetzt investieren um diese Aufgabe zu bearbeiten/dieses Tagesziel zu erreichen?	How much effort do you have to invest right now to work on this task/reach this goal?

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Basic Behavioral Processes Involved in Procrastination

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Procrastination involves an irrational putting off of engaging in a course of action, in spite of expecting to be worse off for the delay. I suggest that to understand the processes underlying procrastination one should examine its relation to several behavioral procedures that have been studied in humans and other animals. For example, in delay discounting, smaller rewards that come sooner are often preferred over larger rewards that come later. In the context of delay discounting, procrastination can be viewed as the preference for an immediate competing activity over the delay to work on a required task. Another process similar to procrastination can be seen in free operant, temporal avoidance (or Sidman avoidance) in which an animal will receive a shock (a deadline not met) if an interval passes without a specified response (task completion). Once animals learn about the interval, they often procrastinate by waiting until the interval has almost passed before responding. Finally, research with animals suggests that the persistence of procrastination may involve a form of negative reinforcement associated with the sudden decline in anxiety or fear (relief) when the task is completed prior to the deadline. Research with animals suggests that the mechanisms responsible for human procrastination may involve systems that derive from several procedures known to produce similar behavior animals.

Keywords: procrastination, delay discounting, delay reduction theory, Sidman avoidance, negative reinforcement

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INTRODUCTION

Comparative psychology has a long history of providing models relevant to human behavior. For example, there is considerable evidence that Pavlovian conditioning procedures are relevant to the conditioning of human emotional response (fear conditioning, taste and odor conditioning, phobias). Similarly, procedures derived from behavior analysis have been found to be relevant to the training of special needs children to care for themselves. They can respond to alternatives in direct proportion to the distribution of reinforcements (the matching law; Herrnstein, 1961; Baum, 1974). Even in the context of complex human decision making, comparative research has demonstrated the relevance of how animals make decisions (Zentall and Wasserman, 2012). Comparative research can provide us with hypotheses concerning the evolution and biological basis of human behavior. Comparative research can often contribute to our understanding of behavior because the learning processes are often simpler in animals than in humans, and we can better control the prior learning experiences. Research with animals does have the drawback that we cannot use their self-report to explain the basis for their choice, so that has to be inferred.

The purpose of the present article is to examine the comparative psychological research for phenomena that might clarify the mechanisms responsible for the tendency for humans to procrastinate. I will start with a brief description of the mechanisms thought to be responsible

for human procrastination. Although procrastination is typically viewed as a uniquely human phenomenon, the results of several, well-studied procedures with animals suggest that the mechanisms involved in procrastination may be closely related to the behavior that one sees in other animals (see Zentall, 2020). With this in mind, I will identify three lines of animal research that suggest they are related to human procrastination. The first, delay discounting is the idea that small immediate rewards are often preferred over larger delayed rewards. Steel and König (2006) have proposed that temporal motivation theory, based on delay discounting, to be the mechanism responsible for human procrastination (see also Steel, 2007). According to this theory, completion of the required task represents the larger delayed reward and competing activities represent the smaller more immediate rewards.

The second line of research is free operant, temporal avoidance, a procedure in which an aversive event is signaled only by the passage of time (Sidman, 1966). It is a procedure that Zentall (2020) identified as analogous to human procrastination in which an animal will receive a shock if it does not make a required response within a defined interval of time.

The third mechanism is negative reinforcement, the idea that the removal of an aversive event can be reinforcing. If completion of the required task relives anxiety it can provide an additional incentive for repeated procrastination. To the extent that these mechanisms are involved in human procrastination, understanding them may allow for a better appreciation for why we procrastinate and potentially, what we can do to reduce its negative effects.

PROCRASTINATION BY HUMANS

Procrastination is often viewed as a trait (e.g., Arvey et al., 2003), and generally a somewhat negative trait (Schouwenburg, 2004). However, it is more realistically viewed as a graded continuum that is affected by many contextual and experiential variables. One way to view procrastination is the balance between the aversiveness of the approaching deadline, together with the anxiety associated with missing the deadline, vs. the attractiveness of alternative activities (e.g., watching television or socializing). Viewed from this perspective, procrastination is typically the choice between an immediate positive activity and the delayed avoidance of a negative outcome (missing a deadline).

Research with animals comes with an inherent challenge, one is limited to their motor behavior because they cannot report how they feel about their choices. On the other hand, what people say about their behavior may not always reflect their underlying motivation. Often humans do not know why they make their choices nor how they feel about them afterwards. Focus on the behavior of animals strips the behavior down to basic principles and allows us to observe the behavior in the absence of human cultural effects. It also allows us to consider the possibility that in the context in which the behavior evolved, the behavior may not be as irrational as it may first appear.

It is well known that humans function using two different systems. One involves implicit (automatic), fast subconscious processes such as procedural, skill, and habit learning that are associated with brain activity in the basal ganglia (Mishkin et al., 1984). The other involves an explicit (controlled), slow conscious process such as executive attention, working memory hypothesis testing and rule formation that are associated with brain activity in the prefrontal cortex, the anterior cingulate gyrus, the head of the caudate nucleus, and the hippocampus (Fuster, 1989). In humans, it is often difficult to separate the implicit and explicit processes that may be involved in procrastination. To the degree that we do not have easy access to the implicit processes that may be present in human procrastination, we may be able to learn about them from studying other animals.

THE EXPLICIT STUDY OF PROCRASTINATION IN ANIMALS

Surprisingly, there has been very little research with animals directed to the study of procrastination itself. This may be because it is difficult to imagine an aversive task for an animal, such as writing a term paper for a human, that can be delayed but not omitted. One of the only studies on animal procrastination was conducted with pigeons (Mazur, 1996). In that experiment, pigeons were given a choice between completing a peck requirement early and completing a peck requirement late. Mazur's procedure was relatively complex so I will go over it. He started with a procedure that looks somewhat like delay discounting. He gave pigeons a choice between making 5 pecks after 6 s or making more than 5 pecks after 20 s (see **Figure 1**). He asked, how many pecks would it take after 20 s for the pigeon to be indifferent between the sooner 5-peck requirement and the deferred increased peck requirement. He found that the pigeons chose to make up to 30 pecks if they could defer pecking for as little as 14 s (the difference between 20 and 6 s).

To further complicate matters, in Mazur's procedure, the time before the peck requirement (as well as after the peck requirement) was signaled by a houselight and during those intervals, intermittent food was provided on a variable time schedule (occasionally, food was made available independent of pecking). The intermittent food presented before engaging in the pecking task can be thought of as humans engaging in pleasurable activities and it is clear that the pigeons preferred to delay engaging in the pecking because they were willing to peck six times as much if they could defer the pecking task. In effect, what this means is that when pecking was required, it represented a period during which reinforcement could not be obtained. Mazur found that the pigeons preferred delaying the nonreinforced peck requirement. They preferred delaying the pecking, likely because the peck requirement interrupted the food-associated houselight cue. Consequently, in addition to deferring the pecking requirement, it is likely that the pigeons preferred to extend the conditioned stimulus (houselight) during which time they could receive food. Extending the conditioned stimulus (houselight) can be thought of as similar to humans choosing to engage in a pleasurable activity such as socializing with friends or watching television, rather than working on a term paper.

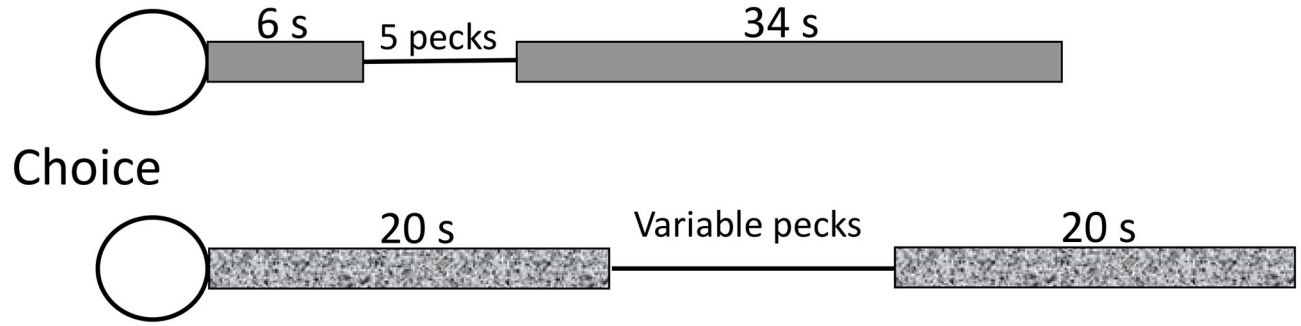

FIGURE 1 | After Mazur (1996). Pigeons were fed during the timed intervals on a variable time schedule (response independent). The variable response requirement was titrated until the pigeon was indifferent between the two chains. The measure of procrastination was the number of pecks required (>5) for the pigeons to be indifferent between the two chains.

PROCRASTINATION AND DELAY DISCOUNTING

When one procrastinates, one is often choosing to delay an aversive activity to engage in a pleasant or less aversive activity. Steel and König (2006) present a theory of procrastination called temporal motivation theory. This theory is based on several human parameters but most notable is the discounting of the value of a future outcome, as a function of the time (or delay) to that outcome. Thus, procrastination can be viewed in the broader context of delay discounting. Delay discounting is generally applied to contexts in which the choice is between a smaller reward sooner and a larger reward later (Ainslie, 1975). Depending on the nature of the reward, the amounts of the smaller and larger rewards, and the delay between the shorter and longer reward, one often finds that there is a smaller sooner reward that will be preferred over the larger later reward. For example, a person might prefer an offer of $5 now over $10 next week.

Research on delay discounting of rewards suggests that humans (and other animals) often make decisions to select a smaller reward sooner rather than a larger reward later, decisions that that are usually considered to be suboptimal (e.g., Odum, 2011). The decisions are suboptimal in the sense that the amount of reward obtained is less than would be obtained had they waited for the larger reward.

Although some have suggested that procrastination, choice of the smaller sooner, involves the irrational putting off of a task (Silver and Sabini, 1981; Akerlof, 1991), in the context of delay discounting, at the time the decision is made, it may not be considered irrational by the decision maker. Even if an individual intends not to procrastinate in advance, and possibly later regrets having procrastinated, it does not alter the fact that at the time the decision to procrastinate was made, it may have been a rational decision—a choice between two alternatives, one that had a greater value to the individual *at that time* than the other alternative.

For humans, when it comes to purchasing things, if one does not have the money, one may charge the items to a credit card, rather than waiting until enough money is saved to buy the items with cash. If the items represent something the individual wants but perhaps does not need, some people would consider these purchases to be irrational. However, choosing the smaller sooner is not always an irrational choice. For example, it is quite rare to wait until one has accumulated enough money to purchase a house. Instead, it is considered quite rational to save enough for a down-payment and then obtain a mortgage for the rest, even if taking on a mortgage means paying much more for the privilege of living in the house sooner. In both of these cases waiting would be aversive, but most people would consider taking out a mortgage for the purchase of a house to be a rational decision, whereas some might consider the purchase of less necessary items to be able to enjoy them right away to be an impulsive irrational choice. Thus, in some cases, it would be considered quite rational to incur the greater cost to obtain the benefit sooner.

One could argue that in the case of procrastination the choice does not involve a deferred reward but a deferred somewhat aversive task. Thus, perhaps a better animal analog to human procrastination is one involving the deferring of an aversive event. Such a procedure was used by Liley et al. (2019). They gave rats a choice between two levers, one that provided one pellet of food and the other that provided three pellets of food. If the rats chose the three-pellet lever, however, they also received a foot shock (analogous to having to complete an aversive task). Although for the rats, the pellets were delivered immediately, the shock was delivered after a delay. What they found was the more delayed the shock, the more preferred was the three-pellet alternative. If one considers the shock to be analogous to an impending deadline, the further off the deadline, the more likely the rats were to choose the more reinforcing three-pellet alternative. That is, when the deadline (shock) was more imminent, the rats chose to avoid the more favorable three-pellet reward with its accompanying penalty (fear of shock) in favor of the less favorable one-pellet reward.

Delay discounting and procrastination both involve the choice between a more immediate positive event and a more delayed alternative event. In the case of delay discounting, the immediate and delayed events are typically appetitive. In the case of procrastination, the immediate event may be appetitive

(e.g., watching TV) or aversive (e.g., washing dishes), but the immediate event is usually less aversive than the delayed event (e.g., writing a term paper).

THE POWER OF THE HYPERBOLIC FUNCTION OF DELAY DISCOUNTING

Some have proposed that it is considered procrastination only when delaying the start of the task is unintentional (Silver and Sabini, 1981; Lay and Silverman, 1996). That is, if one intentionally delays the start of the task it would be considered an informed planned decision, unlikely to create anxiety. One can argue, however, that procrastination is always intentional, at least it is *at the time* one *decides to procrastinate*. Although one may come to regret the decision to procrastinate later, at the time the decision to procrastinate was made, one could argue that it was an intentional decision to put off completing the required task. Alternatively, when one procrastinates, one does not consider the likely negative effects of procrastination. It is not always a choice but it may be an impulsive decision to engage in the alternative activity. This realization may identify one means of dealing with both procrastination and the impulsive choice of the smaller sooner reward. If one understands the appeal of the smaller sooner reward, one can plan ahead to avoid putting oneself in a position to make that choice. For example, to avoid the "temptation" to socialize with friends or watch TV, a student may decide to go to the library to begin working on a term paper. One can think of going to the library as making a *prior commitment* to work on the paper. Ariely and Wertenbroch (2002) found that people are willing to create self-imposed deadlines to help overcome procrastination.

Surprisingly, a similar effect can be demonstrated in non-human animals. The concept of making a prior commitment was tested in pigeons by Rachlin and Green (1972). They first showed that for a given choice between a smaller sooner reward and a (two times) larger later reward, the delay was such that the pigeons preferred the smaller sooner reward. They then modified the procedure such that 10 s prior to being given the choice between the smaller-sooner/larger-later reward, the

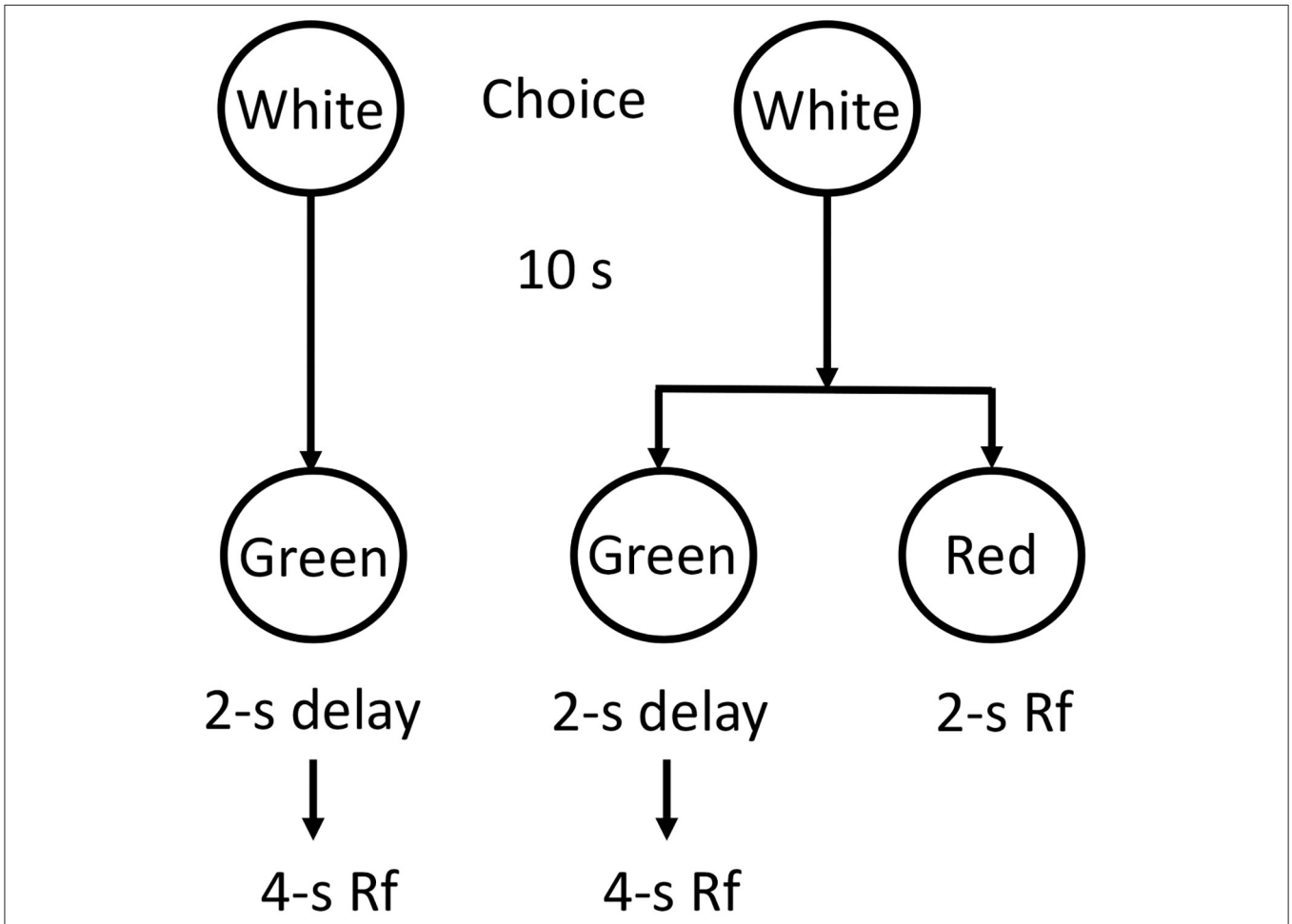

FIGURE 2 | Design of the Rachlin and Green (1972) experiment. Given an immediate choice between Green (2-s delay and 4-s reinforcement) and Red (immediate 2-s reinforcement) pigeons preferred Red. However, given an initial choice between Green alone or a choice between Green and Red, pigeons preferred Green alone. It looks like they make a "commitment" to avoid the "temptation" to choose Red.

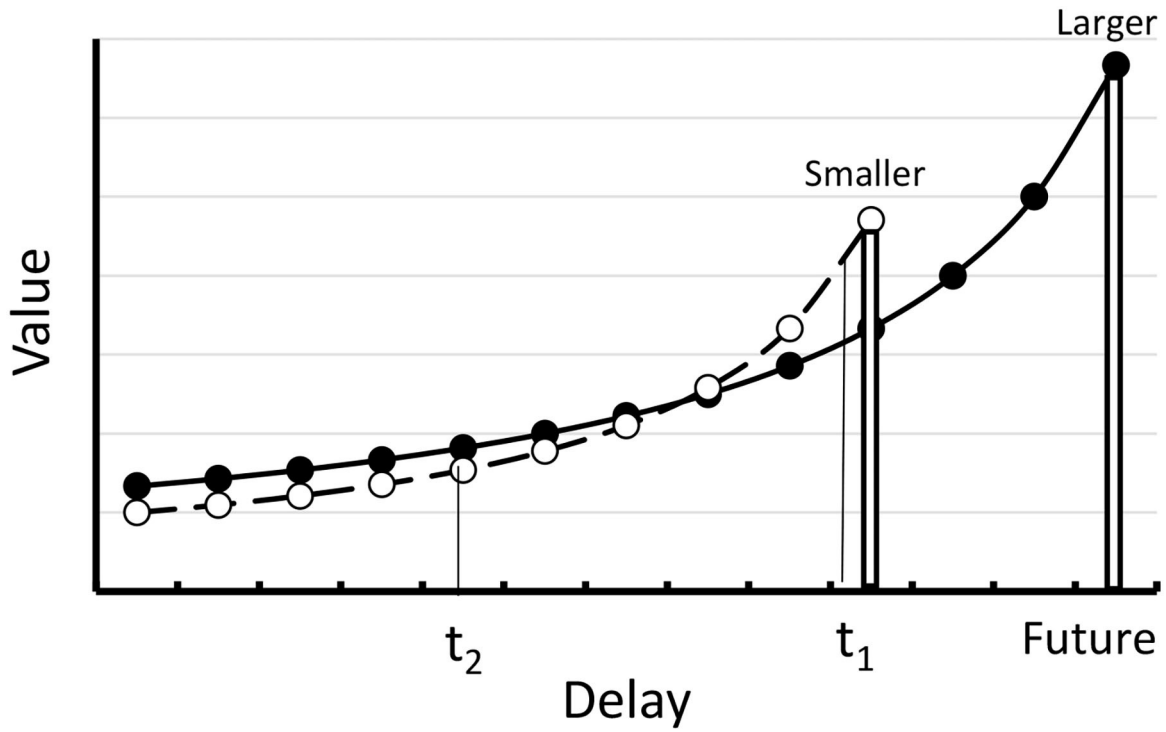

FIGURE 3 | Hyperbolic delay discounting function. At time 1 (t_1) the value of the smaller reward is greater than the value of the larger reward. At time 2 (t_2) there is a reversal of preference.

pigeons were given a choice between receiving the delayed smaller-sooner/larger-later choice and making a commitment to receive only the larger-later outcome (see **Figure 2**). That is, they could choose to later choose between the smaller sooner and larger later or choose to commit to the larger later. When given this earlier choice, the pigeons elected to avoid the later smaller-sooner/larger-later choice and instead they chose to commit themselves to the larger later reward. Thus, getting the pigeons to make a prior commitment got them to make the optimal choice. For the student needing to write the term paper, the decision to go to the library to work on her term paper before encountering the immediacy of alternative pleasurable activities, likely serves a similar function.

Nature of the Function: Exponential With 2 Different k Values or Hyperbolic With Only One

The decline in the delay discounting function with time to reinforcement can be described either by an exponential decay function or a hyperbolic decay function. The exponential (e) would take the form of Equation 1 (Mazur, 1987) in which V = the value of the discounted reward, A = the magnitude of the reward, D = the delay to the reward, and k = a constant that represents the rate at which the value declines with delay.

$$V = Ae^{-kD} \tag{1}$$

The hyperbolic decay function would take the form of Equation 2 (Mazur, 1987).

$$V = \frac{A}{1 + kD} \tag{2}$$

In this equation, as well, V = the value of the discounted reward, A = the magnitude of the reward, D = the delay to the reward, and k = represents the rate at which the value declines with delay.

The exponential conforms empirically to the preference for the smaller sooner over the larger later reward, but it does not account for the well documented reversal of preference when equal increments in delay are added to both the smaller and larger rewards (Rachlin and Green, 1972; Ainslie, 1974; see **Figure 3**). The exponential decay function can be salvaged if one assigns greater k value to the smaller sooner reward than to the larger later reward, but that requires two different values to the k parameter.

The hyperbolic delay function (see **Figure 3**) allows for the reversal of preference without assuming two different values of k. According to the hyperbolic decay function, assuming that at time t_1 one prefers the smaller sooner reward over the larger later reward, the preference can reverse if the choice between the smaller sooner and larger later can be made somewhat earlier (e.g., at t_2 rather than at t_1). Thus, the hyperbolic function can explain how it might be that before the choice between the task and competing activities are immanent, at a time when one has

the intention of start to work on the task at an appropriate time, one can make a commitment to not be tempted by other activities. According to the hyperbolic delay discounting function, in the absence of such a commitment, when other activities become more immediate, they will take on more value and will complete more successfully with the larger later task.

THE FREE OPERANT, TEMPORAL AVOIDANCE PROCEDURE

Delay discounting is the basis of Steel and König (2006) temporal motivation theory. It is based on the discounting of rewards that will occur in the future. The weakness of delay discounting as an account of procrastination is it does not capture the build-up in anxiety that often accompanies procrastination because the in the typical delay discounting procedure, the delayed event is not aversive. A better analog of procrastination that does involve a future aversive task is the free operant, temporal avoidance procedure (Sidman, 1966, often referred to as Sidman avoidance). With this procedure, for example, a rat is given a shock unless it makes a response (e.g., jumping over a barrier) and it must do so, for example, within 20 s of its last response (or shock). In spite of the fact that there is no external stimulus presented to alert the rat to the impending shock, rats readily learn to jump over a barrier to avoid the shock. An interesting problem for learning theory is, given that a rat learns to successfully avoid the shock, it does so for a very long time. But what maintains the response in the absence of an occasional shock to support the jumping response (see Solomon et al., 1952).

According to Mowrer's (1947) two-factor theory, in avoidance learning there are two factors. The first factor is the Pavlovian association that develops between the signal for shock (in this case the passage of time) and the shock. Due to that association, the passage of time following the last response or shock is presumed to elicit fear. The animal then learns that the cues (feedback) from making the instrumental response (the jump) become safety signals for the absence of shock (see Bolles and Grossen, 1969). Those safety signals result in fear reduction, negative reinforcers. Thus, in Sidman avoidance, although there is no external signal for shock, the passage of time since the last response or shock may serve such a function.

If fear of shock in the free operant temporal avoidance procedure is analogous to fear (or anxiety) associated with missing the deadline for humans, one might expect to see a form of procrastination by the rats as they learn about the contingencies of the task. In the temporal avoidance procedure, to avoid getting shocked, the rats can jump over the barrier at any time before the shock. Once they have learned the contingencies of the task, a temporal discrimination, however,

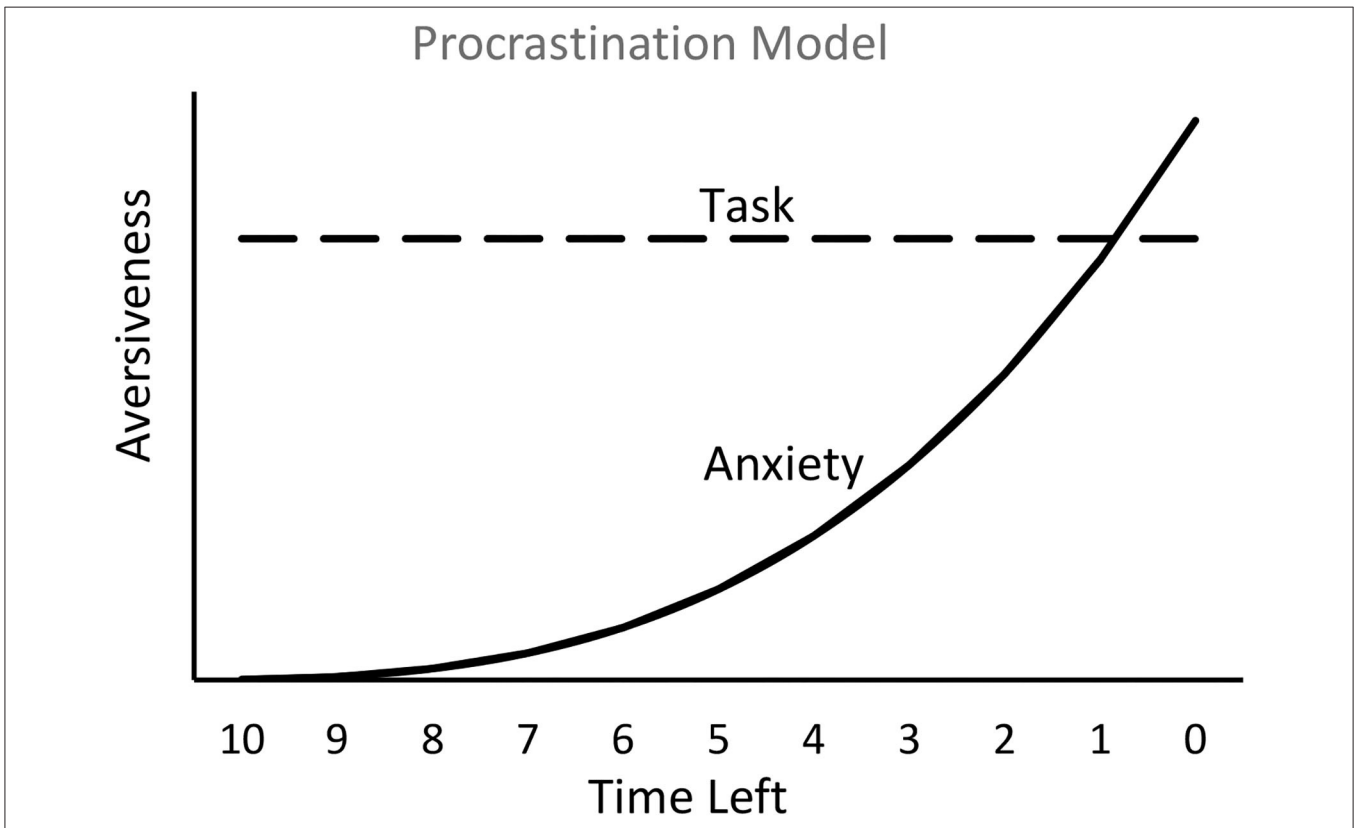

FIGURE 4 | Hypothetical plot of the relation between the interaction of two emotions, the aversiveness of the task and the aversiveness of anxiety resulting from the fear of doing poorly or of missing the deadline. The model predicts that work on the task will begin when anxiety approaches the aversion to the task.

they tend not to press the lever immediately following the last response or shock. Instead, they generally delay making the shock avoidance response until near the end of the interval (Sidman, 1962; Hineline and Herrnstein, 1970). That is, they tend to procrastinate by waiting until shortly before the shock would arrive.

According to two-factor theory, the passage of time increases fear, but with training, the rats learn that shock will not come early in the interval, so they are not fearful, and they do not press earlier than they need to. The fear presumably builds up gradually until it reaches the point at which the shock is soon expected, and then the response is made.

A simplified model of human procrastination is assumed to follow a time course similar to that of the temporal avoidance procedure. The aversiveness of the task is relatively constant, whereas the anxiety (presumably resulting from the fear of not completing the task prior to the deadline) builds up, gradually at first and then progressively faster (see **Figure 4**). The model presented in **Figure 4** assumes that the source of procrastination is competition between two aversive motivations, task aversiveness and anxiety. From a learning theoretic perspective, however, one might expect that the many experiences of building anxiety that one undergoes, over many instances of task postponement, would result in reduced procrastination. In fact, people who procrastinate often do have regrets (Ferrari et al., 2009), and they often assert that in the future they will start working on the required task earlier—a resolution that often goes unfulfilled. A possible explanation for the maintenance of procrastination, even with continued feelings of frustration at the build-up of anxiety each time, is that the procrastination behavior itself may be reinforced. I will now address that possibility.

RECENT ANIMAL RESEARCH

Can Task Completion Shortly Before a Deadline Serve as a Reinforcing Event?

As noted earlier, people who procrastinate often vow that in the future they will start working on the required task earlier. Yet, chronic procrastinators rarely do. To account for persistent procrastination, one can posit that there is something about procrastination itself that is reinforcing. If procrastination produces an increase in anxiety (a negative affect), a reasonable source of reinforcement might be negative reinforcement in the form of relief (the removal of an aversive event) when the task has been completed before the deadline. Furthermore, the closer to the deadline the task is completed, the greater would be the anxiety prior to working on the task and thus, the greater the magnitude of the negative reinforcer would be upon task

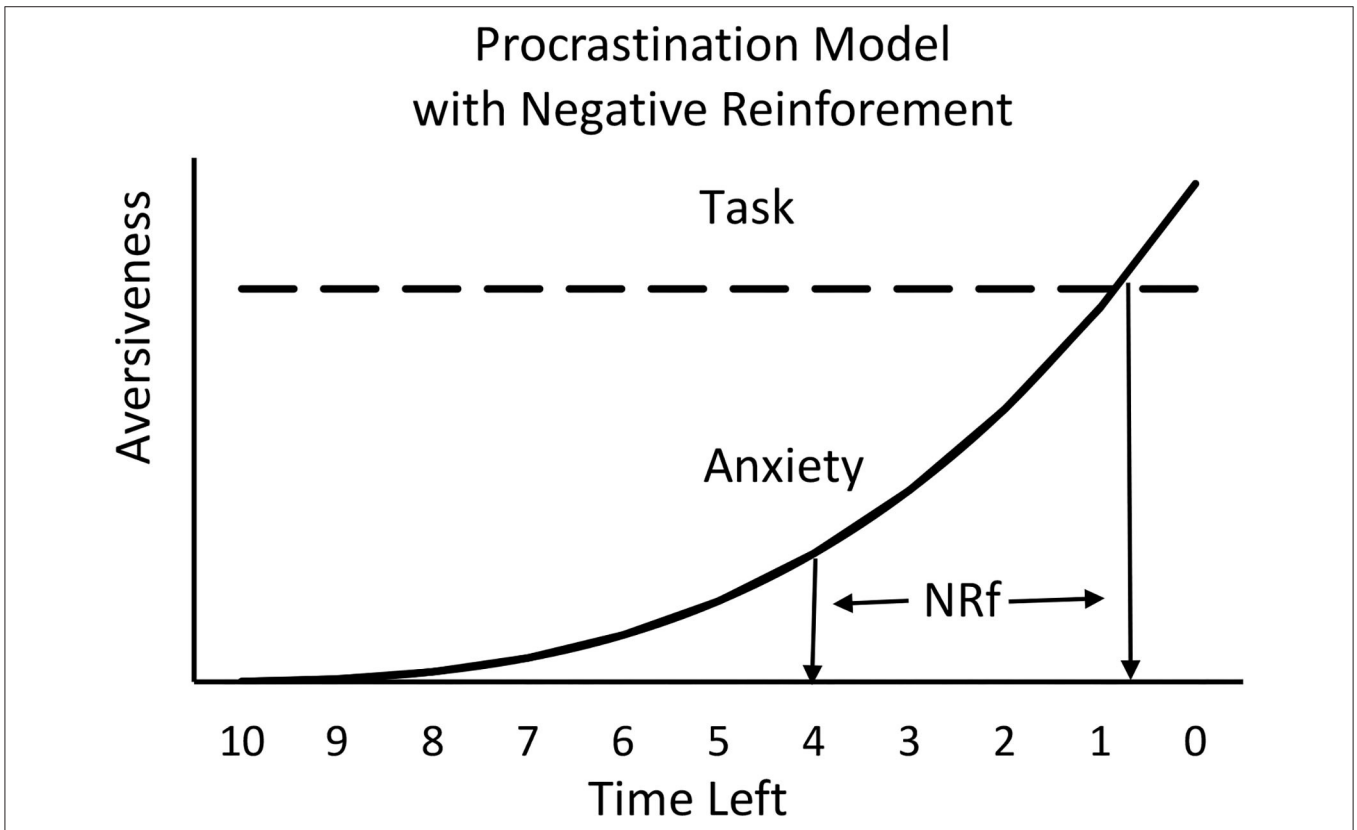

FIGURE 5 | Negative reinforcement (NRf) associated with the reduction in anxiety will depend on the amount of anxiety experienced and will increase as the time left approaches the deadline.

completion. For this reason, it is possible that the sense of relief that one experiences when completing a task close to the deadline actually maintains procrastination. A model of this negative reinforcement effect appears in **Figure 5**, a modification of **Figure 4**.

To better understand the negative reinforcement that may contribute to procrastination, it may be useful to consider the stimulus events that take place, independent of whether the task outcome is negative or positive reinforcement and relate those events to basic principles of reinforcement.

Fantino's (1969) delay reduction theory provides a useful foundation. According to delay reduction theory, signals for reinforcement become stimuli associated with reinforcement (conditioned stimuli) to the extent that they predict reinforcement better when they are present than when they are absent. This appears to be a simple premise, but it makes some important predictions. According to this theory, it is not only how close in time the signal is to reinforcement, but it is how close in time the signal is to reinforcement, *relative to other events*. A nonobvious prediction of delay reduction theory is, given that a stimulus occurs at a fixed time from reinforcement, the longer the interval *prior* to the onset of that stimulus, the better a conditioned stimulus it will become (Fantino, 1969). That is, it is the *relative* proximity to the reinforcer rather than its absolute proximity that is crucial. Thus, the longer the interval between a given stimulus-reinforcer pairing, the more effective the conditioned stimulus should become. Gibbon et al. (1977; see also Singer et al., 2007) have found support for this prediction.

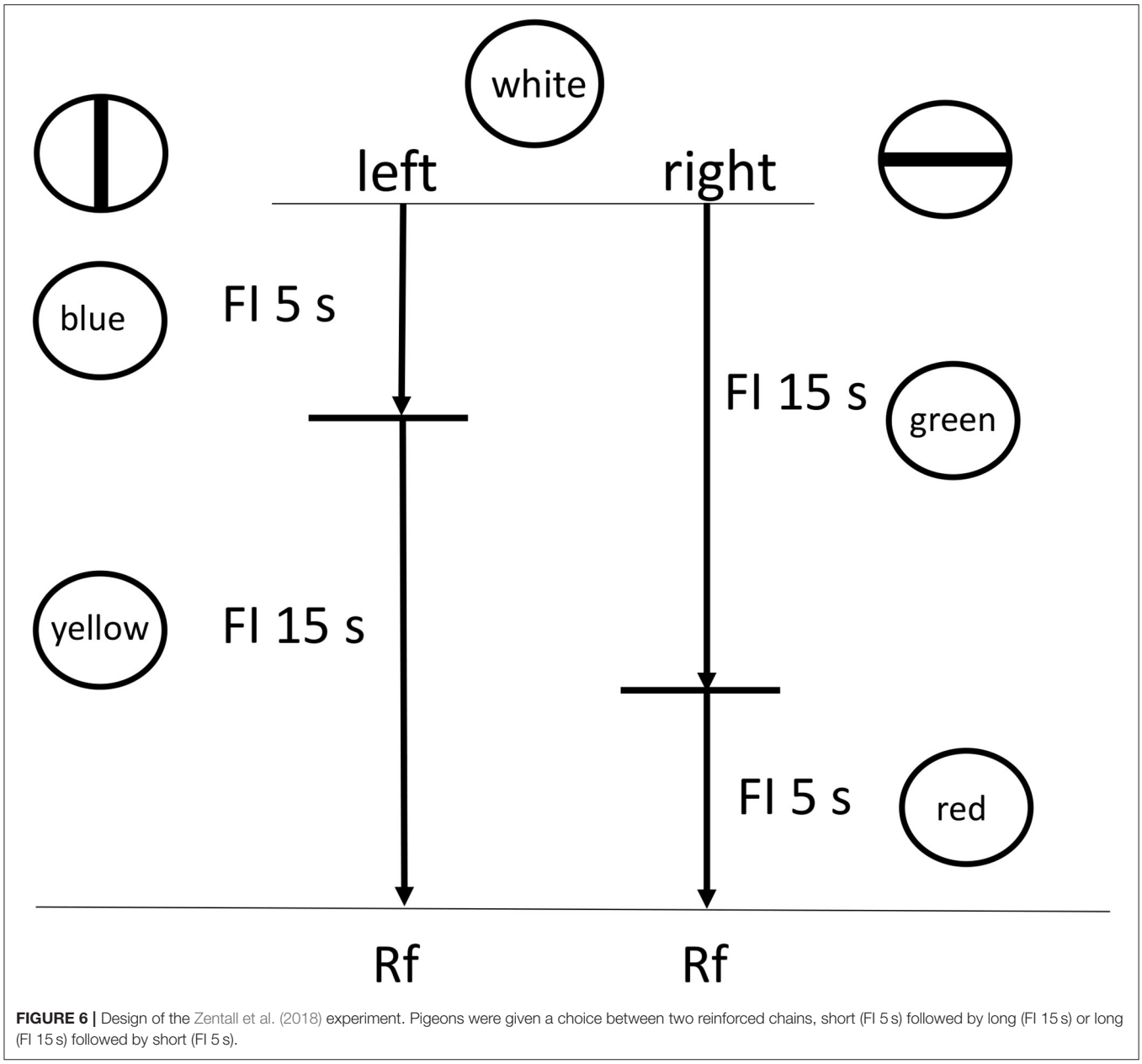

FIGURE 6 | Design of the Zentall et al. (2018) experiment. Pigeons were given a choice between two reinforced chains, short (FI 5 s) followed by long (FI 15 s) or long (FI 15 s) followed by short (FI 5 s).

To better understand this concept, imagine that the pairing of a light with food occurs every 10 s. In this case, it should be relatively easy to predict the occurrence of food, even in the absence of the light. If the pairing of the light with the food occurred once every hour, however, it would be relatively difficult to predict the food in the absence of the light. Thus, the light would become a better signal for the occurrence of food.

Before seeing how this theory may apply to procrastination, we decided to test delay reduction theory in a context more relevant to procrastination than had been done earlier. That is, with a procedure in which the total time to reinforcement (the "deadline") is held constant, but the duration of conditioned stimulus associated with the deadline is varied.

Imagine the following scenario: there is a fixed delay to reinforcement (or in the case of procrastination, the deadline) with a choice between two stimulus chains (to procrastinate or not). One chain starts with presentation of a long interval, signaled by Stimulus A (analogous to the period of procrastination, before working on the task), followed by a short interval, signaled by Stimulus B (analogous to time working on the task), followed by reinforcement (see **Figure 6**). The other chain starts with presentation of a short interval, signaled by Stimulus C (time working on the task), followed by a long interval, signaled by Stimulus D (time after working on the task), followed by reinforcement. At this point there is no actual task, just stimuli that signal time periods prior to the reinforcer.

According to delay reduction theory, although the two chains represent the same total delay to reinforcement, the chain represented by the long interval followed by the short interval presents a short interval just prior to reinforcement. Thus, that stimulus should serve as a very good, conditioned stimulus. Not only should the short Stimulus B be preferred over the long Stimulus D that also appears just prior to the reinforcer, but importantly, the short Stimulus B also should be preferred over the short Stimulus C that occurs earlier in the other chain (Fantino, 1969). If presentation of the long interval early can be thought of as analogous to deferring task completion, and presentation of the short stimulus early as analogous to completing the task early, could experiencing the short stimulus immediately before the reinforcer (the deadline) be more reinforcing than experiencing the short stimulus earlier?

Initially, we tested this hypothesis by asking if pigeons would prefer a long-short interval chain over a short-long interval chain, both of the same total duration. In our first experiment (see **Figure 6**), the pigeons showed a 2–1 preference for the long-short interval chain over the short-long interval chain (Zentall et al., 2018). In addition, the relative peck rate to the short 5 s stimulus that was immediately followed by reinforcement (Stimulus B) was significantly greater than to both the short 5 s stimulus (C) that was followed by the relatively long 15 s stimulus (D), and to the relatively long 15-s stimulus (D) that was immediately

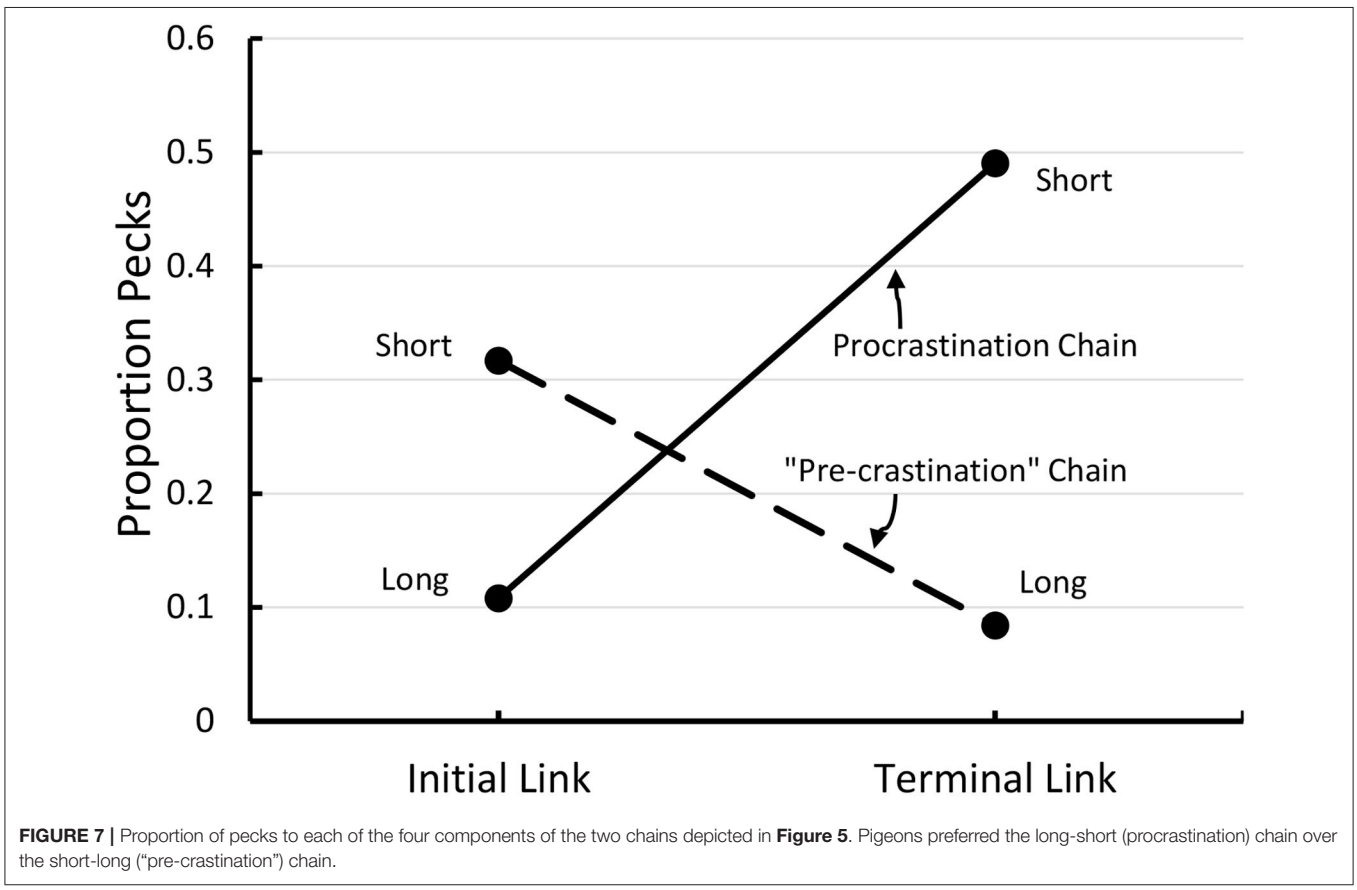

FIGURE 7 | Proportion of pecks to each of the four components of the two chains depicted in **Figure 5**. Pigeons preferred the long-short (procrastination) chain over the short-long ("pre-crastination") chain.

followed by reinforcement (see **Figure 7**). Thus, it appears that the short stimulus that was followed by reinforcement became a stronger conditioned stimulus, and it is likely that it was responsible for the preference for the long-short interval chain.

Although this experiment did not include an aversive event or a task that one would normally associate with procrastination, it did show that task completion events close to the deadline may become strong conditioned stimuli. The next step was to interpolate a mildly aversive event between the two intervals in each chain to simulate a task that elicits the motivation to defer.

Given the nature of the concurrent chains task, we were looking for an event that had been shown to be mildly aversive, one that might be seen as analogous to writing a term paper. McDevitt et al. (1997) found that preference for a conditioned stimulus was greatly reduced when a period with no stimulus, a dark period preceded it, even when the dark period did not increase the time to reinforcement. If one views the dark period as a mildly aversive event, one can ask, if pigeons are not able to avoid a dark period, would they choose to defer the dark period to later in the trial?

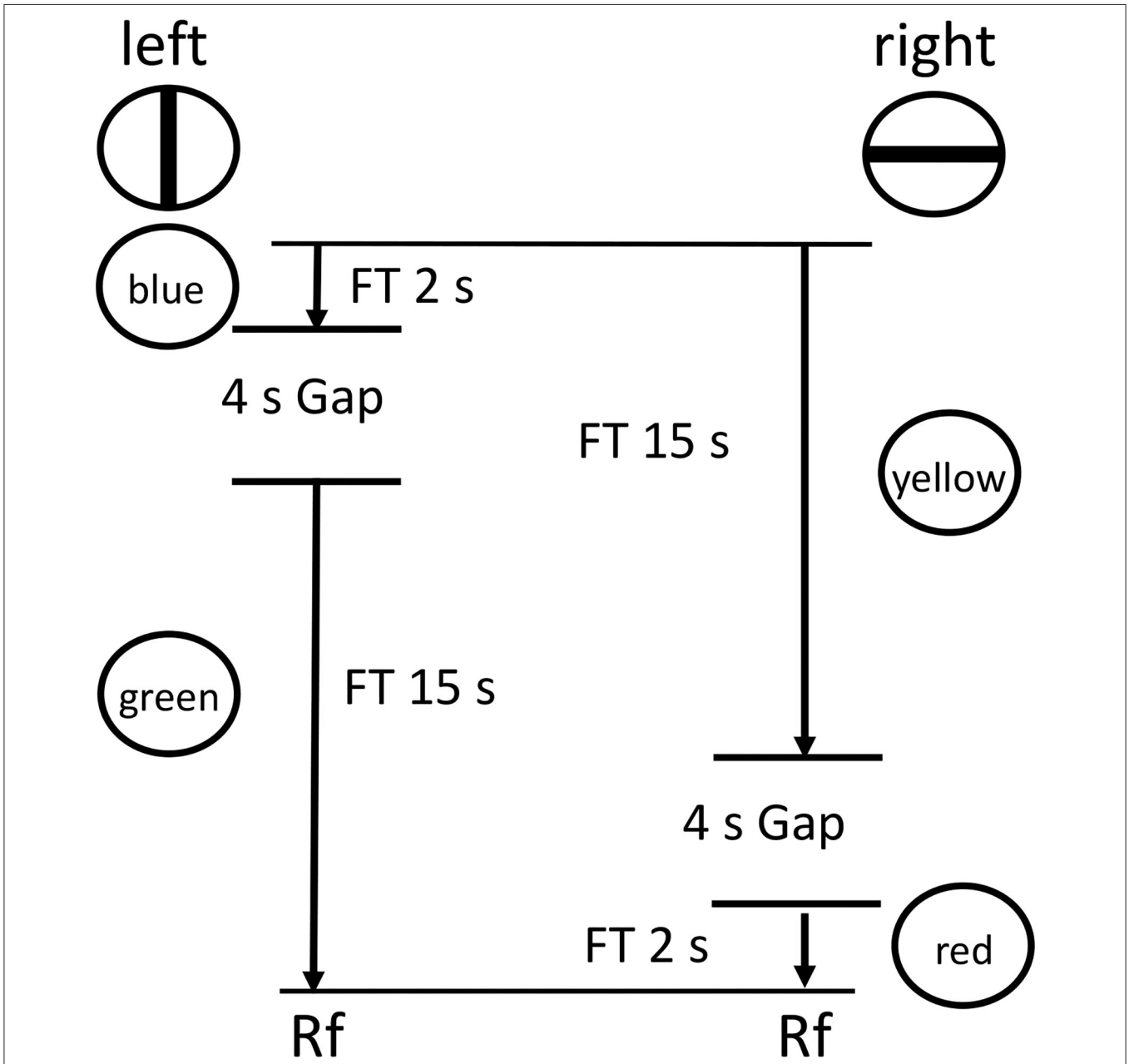

FIGURE 8 | Design of the Zentall et al. (2020, Experiment 1) experiment. Pigeons were given a choice between two reinforced chains, short (FI 2 s) followed by long (FI 15 s) or long (FI 15 s) followed by short (FI 2 s), with a 5 s dark period (a gap) between the two links of each chain.

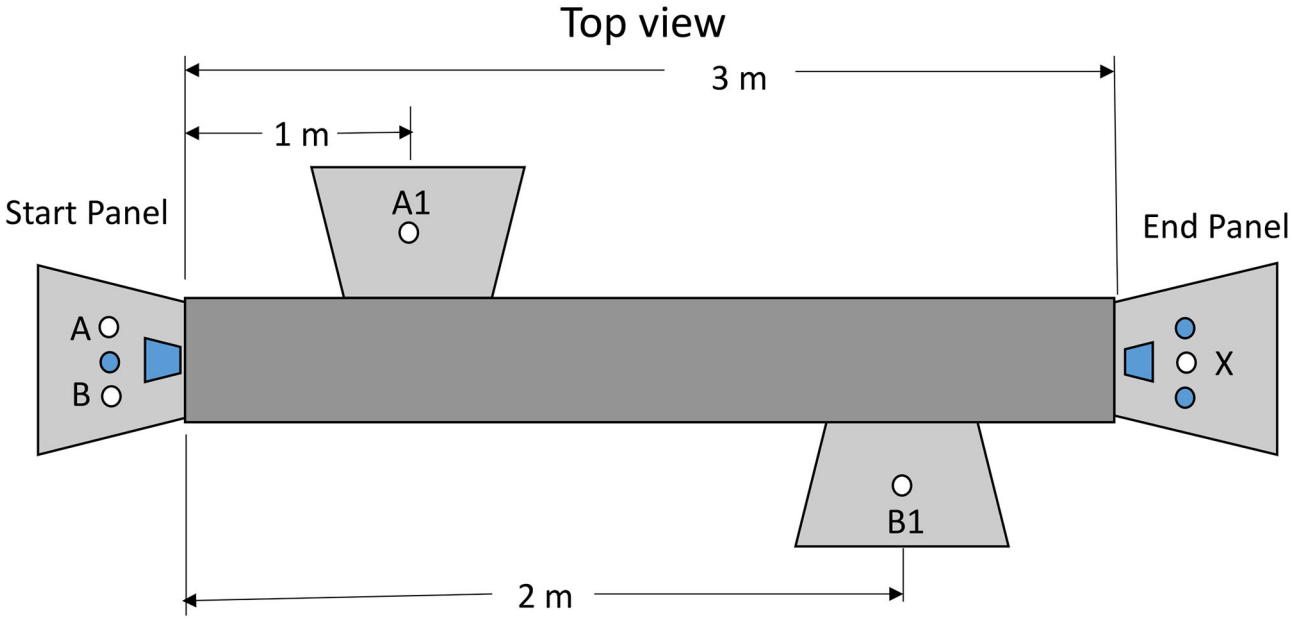

FIGURE 9 | Apparatus used in the Zentall et al. (2020, Experiment 1). Pigeons made a choice between stimulus lights A and B. If they chose A, they would have to peck A1 10 times and then peck stimulus X for reinforcement. If they chose B, they would have to peck B1 10 times and then peck stimulus X for reinforcement.

Zentall et al. (2020, Experiment 1) tested pigeons with a procedure similar to that used by Zentall et al. (2018) but they added a 4 s dark period between the two intervals in each chain (see **Figure 8**). They found, once again, that pigeons chose to delay experiencing the relatively aversive dark period. That is, they procrastinated receiving the aversive dark period.

Although we now had suggestive evidence that pigeons would defer a relatively aversive dark period in a chain that led to reinforcement, we wanted to test pigeons with a task that more closely resembled a human procrastination task. For that purpose, we selected a task in which to obtain a reinforcer, the pigeon had to walk from one end of a long cage to the other end of the cage (see **Figure 9**). On the way, the pigeon had to perform a pecking task (Zentall et al., 2020, Experiment 2). The pecking could occur closer to the start or closer to the goal (farther from the start). The results of this experiment indicated that the pigeons preferred to defer the peck requirement. That is, they preferred to procrastinate making the side-key pecking response.

Taken together, the results of the pigeon research are consistent with the hypothesis that deferring a task requirement can be reinforcing for pigeons. For humans, if one considers the relief that one feels upon completion of a task as serving as a negative reinforcer, and the closer task completion comes to the deadline, the greater the negative reinforcer (the removal of an aversive event), it can potentially explain why it is that procrastination can become a habitual behavior. Although one may readily remember the build-up of anxiety that occurs as the deadline approaches, and that build-up of anxiety may be responsible for a pledge to avoid procrastinating in the future, it may well be that it is the relief from anxiety that occurs upon completion of the task that makes it difficult to stick to one's intention not to procrastinate in the future.

CONCLUSIONS

The ubiquity of procrastination suggests that certain basic behavioral processes are likely to be involved. The fact that these basic behavioral processes demonstrate behavior similar to human procrastination suggests that cultural factors are not likely to be necessary and individual differences such as laziness, fear of failure and perfectionism are not critical components. Temporal motivation theory proposed by Steel (2007) demonstrates the role that delay discounting plays in procrastination and that phenomenon has been widely demonstrated in humans and other animals (e.g., Ainslie, 1974). In addition, it is very likely that free-operant temporal avoidance learning (Sidman, 1966), delay reduction theory (Fantino, 1969), and negative reinforcement (Zentall et al., 2020) all contribute to procrastination and especially to its persistence. Although some researchers have viewed procrastination as a trait rather than as behavior that is context and experience dependent, the involvement of these basic mechanisms suggests that people may learn to procrastinate. Furthermore, if negative reinforcement, associated with the abrupt decline in anxiety that typically accompanies task completion, reinforces procrastination, it may be difficult for one to avoid procrastinating in the future, even if one has the best of intentions. The demonstration of the similarity of

the behavior of non-human species to human procrastination suggests, importantly, that cultural factors as well as human traits such as perfectionism, laziness, and fear of failure are not necessary to explain human procrastination.

DATA AVAILABILITY STATEMENT

Publicly available datasets were analyzed in this study. These data can be obtained from the author at zentall@uky.edu.

ETHICS STATEMENT

The animal studies reported here were reviewed and approved by the University of Kentucky Institutional Animal Care and Use Committee.

AUTHOR CONTRIBUTIONS

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

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Gender, Socioeconomic Status, Cultural Differences, Education, Family Size and Procrastination: A Sociodemographic Meta-Analysis

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Procrastination describes a ubiquitous scenario in which individuals voluntarily postpone scheduled activities at the expense of adverse consequences. Steel (2007) pioneered a meta-analysis to explicitly reveal the nature of procrastination and sparked intensive research on its demographic characteristics. However, conflicting and heterogeneous findings reported in the existing literature make it difficult to draw reliable conclusions. In addition, there is still room to further investigate on more sociodemographic features that include socioeconomic status, cultural differences and procrastination education. To this end, we performed quantitative sociodemographic meta-analyses (k = 193, total n = 106,764) to fill this gap. It was found that the general tendency and academic procrastination tendency of males were stronger than females (r = 0.04, 95% CI: 0.02–0.05). No significant effects of differences in socioeconomic status (i.e., poor or rich), multiculturalism (i.e., Han nation or minorities), nationality (i.e., China or other countries), family size (i.e., one child or > 1 child), and educational background (i.e., science or arts/literature) were found to affect procrastination tendencies. Furthermore, it was noteworthy that the gender differences in procrastination tendencies were prominently moderated by measurements, which has a greater effect on the Aitken Procrastination Inventory (API) (r = 0.035, 95% CI: −0.01–0.08) than on the General Procrastination Scale (GPS) (r = 0.018, 95% CI: −0.01–0.05). In conclusion, this study provides robust evidence that males tended to procrastinate more than females in general and academic profiles, and further indicates that procrastination tendencies do not vary based on sociodemographic situations, including socioeconomic status, multiculturalism, nationality, family size, and educational background.

Keywords: procrastination, sociodemographics, multicultures, meta-analysis, gender

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INTRODUCTION

Procrastination is a stable harmful tendency within individuals, defined as the voluntary but irrational delay of intended course of actions (Elliot, 2002; Steel, 2007). In addition, the procrastination also refers to an off behavior that keeps unnecessary delay and reap negative consequences caused by this delay *per se* (van Eerde, 2000, 2003). The absolute number of procrastinators is sizeable (Potts, 1987), with approximately

75% of college students considering themselves procrastinators and nearly half of them procrastinating consistently and problematically (Steel and Ferrari, 2013). Furthermore, procrastination significantly harms people's health, well-being, work efficiency and academic performance (Kachgal et al., 2001; Sirois, 2007; Balkis and Erdinç, 2017). An earlier meta-analysis thoroughly and explicitly reviewed the nature of procrastination and revealed how procrastination is associated with many variables, such as personality, mental health and demographic features (van Eerde, 2003; Eerde, 2004; Steel, 2007).

However, the conflicting results for the association between gender and procrastination were observed frequently in existing studies. For instance, Li (2013) and colleagues used large-scale sample to report the strong effect for the gender differences in procrastination among Chinese students, with more procrastination in males (Li, 2013). In addition, this conclusion is also supported by the Turkish population (Nilufer, 2017). However, the inconsistent results reported show that there is no gender differences in procrastination (Ajayi, 2020; Wang, 2020). To make matters worse, a portion of studies provided evidence to claim more procrastination in females instead of males (Bian, 2017; Song et al., 2020). In this vein, so far there is no solid evidence to clarify this association. Furthermore, as the close linkage between socioeconomic status (SES) and the self-regulation (Miller et al., 2015), the role of SES on procrastination that caused by the failure of self-regulation also caught our eyes. Nevertheless, results for such relations were found heterogeneous: Yao (2020) reported a significant negative correlation between SES and procrastination (Yao, 2020), whereas provided null findings in other studies (Huang et al., 2017; Xing, 2019). Thus, the needs for a meta-analytic evidence to clarify the association between SES and procrastination emerged. Further, the association between education and procrastination is still sparked much interests for us, but remains inconsistent conclusions. Ferrari et al. (2009a) have demonstrated results for claiming the negative relationship between education and procrastination (Ferrari et al., 2009a). However, graduates students were found procrastinate more than students in high and middle schools (Wen, 2014; Li, 2019). Thus, it leads us to infer the association between the education and procrastination, as well to promote a need to clarify what the direction is for such influence.

A considerable body of meta-analyses on procrastination has been conducted. Steel (2007) provided the correlation between procrastination and other psychological features, and revealed that task aversiveness, task delay, self-efficacy, impulsiveness, conscientiousness, self-control, distractibility, organization, and achievement motivation are strong predictors of procrastination. However, demographic features such as age are not significant predictors of procrastination (Steel, 2007). More recent meta-analyses have discussed demographic features of procrastination (Balkis and Erdinç, 2017; Krispenz et al., 2019) and focused on the relation between specific topics such as procrastination and time perspective (Sirois, 2014), academic performance (Kim and Seo, 2015; Sæle et al., 2017) and intervention (van Eerde and Klingsieck, 2018). In addition to the general demographic features of procrastination and these specific features, other social factors should be probed, including SES, cultural differences, and educational background.

Both 4-dimensional theoretical model and competing theory of SES have suggested that SES is defined as a measure of individuals' combined economic and social status, which may influence many aspects of personal behaviors, such as smoking, addiction and drinking (Pampel and Rogers, 2004; Cutler et al., 2008; Baker, 2014). A previous study suggested that individuals with lower SES procrastinate in treatment or hospitalization and/or do have apply for health insurance (Weissman et al., 1991). In addition, lower SES affects the procrastination tendency of college students, as students with lower SES are more worried about their financial situation, which triggers anxiety and leads to increased academic procrastination (Stöber and Joormann, 2001). Similarly, differences in SES can also explain to certain extent the tendency of individuals to use Facebook to avoid or procrastinate on tasks (Arnett, 2016). Furthermore, a recent study measured childhood SES and investigated its relationship with procrastination found that SES is closely related to procrastination *via* parenting style and conscientiousness trait (Shimamura et al., 2021). Such associations could be attributed to the personality-trait formation. In detailed, the high SES was found to make children prone to form conscientiousness trait that is significantly factor to persist procrastination (Noftle and Robins, 2007; O'Connor and Paunonen, 2007; Lubbers et al., 2010). Another pathway to explain why SES could influence procrastination is the variability of self-control ability. Existing evidence indicated that the low SES was a risk factor to make children and students posing less self-control and self-regulation ability (Johnson et al., 2011; Ng-Knight and Schoon, 2017).

In addition, the bidirectional interplay of SES and procrastination could be ascribed to the mediated role of impulsivity. Gustavson et al. (2014, 2015) have demonstrate the robust genetic association between procrastination and impulsivity, with high impulsivity in procrastinators (Gustavson et al., 2014, 2015). Further, it is noteworthy that the high impulsivity could be a reliable predictors for low SES (Assari et al., 2018; Walsh et al., 2019). In this vein, it promotes us to infer that the high impulsivity may make participants prone to procrastinate more for causing poor academic or professional achievements, which in turn, bring about low SES. However, other studies suggested that college students ranging from lower to upper SES backgrounds showed no significant difference in their scores in an university program that aimed to measure academic procrastination (Pychyl et al., 2002). Hence, the relationship between SES and procrastination remains ambiguous, and it is worth exploring through meta-analysis methods.

It has been proposed that cultural differences in norms and values exist in the perception of time that may affect individuals' evaluation of long-term consequences and risk avoidance, which may thus affect procrastination (Brislin and Kim, 2003). A previous study found that the prevalence of procrastination among British citizens is higher than that among American or Australian citizens, demonstrating that procrastination is more common in Westernized, individualistic, English-speaking countries than in other countries (Ferrari et al., 2005a). In

addition, it was found that cultural differences between the United States and Russia are related to procrastination caused by the use of the Internet for social interaction (Doty et al., 2020). Likewise, the same conclusion was found in non-Anglo-Saxon population as well. For example, the problematic procrastination was observed more in Mongols than do of Chinese population (Wang, 2014). In contrast, a group of studies exploring adult procrastination in different cultures found that procrastination is common in every situation, and the procrastination patterns of arousal and avoidance show cross-cultural similarities rather than differences (van Eerde, 2003; Ferrari et al., 2007; Klassen et al., 2009). This claim—that is—no significant cultural differences in procrastination was supported in non-Anglo-Saxon populations, such as Bourau, India and Tibet (Kuang, 2012; Song, 2014). In addition, a study surveying college students from Ukrainian and Slovak revealed that there were no statistically significant differences in procrastination between Ukrainian and Slovak students (Košíková et al., 2020). Overall, it is worthy to explore there were cultural differences for procrastination in the current study.

An interesting association for the procrastination is that delaying off courses irrationality would increase likelihood to remain singe in marital relationship, which caused to a reduction in the size of the family (Moore, 2004). Further, the procrastination was found to be a predictor for divorced rates and it would make individuals hard to obtain romantic relationship (Roberts et al., 2007; Steel, 2010b). A straightforward evidence provided by Steel and Ferrari (2013) indicated the negative association between the procrastination and family size. On the other hand, the high fertility rate was found prominently in individuals with less conscientiousness, which is the key predictor for procrastination (Bouchard, 2005). Thus, the current study is also interested in whether the family size could link to procrastination.

Moreover, educational background has long been regarded as a potential indicator of procrastination tendencies (Ferrari et al., 1995, 2009b; Steel and Ferrari, 2013). Liberal arts students and science students are exposed to different teaching structures and content (Jacobsen, 2006; Van der Wende, 2011) and therefore may differ in their level of procrastination. Conscientiousness is a strong predictor of both academic performance and procrastination (Noftle and Robins, 2007; O'Connor and Paunonen, 2007; Steel, 2007). Later research found a negative relationship between procrastination and academic math performance comparable in strength with that of conscientiousness (Lubbers et al., 2010). Thus, we may deduce that science students procrastinate less than liberal arts students. However, another study investigated whether procrastination is related to student majors and found no significant difference in procrastination tendencies among students of different majors (Zarick and Stonebraker, 2009). Thus, what the association between educational background and procrastination is could be examined by using meta-analysis in the current study.

As conflicting results for the association between procrastination and some demographic characteristics were consistently found, the potential factors to impact these results have also sparked much interests in current study (Pychyl et al., 2002; Özer et al., 2009; Steel and Ferrari, 2013). Svartdal and Steel (2017) have pioneered the examination and revision for five mainstreaming scales, and indicated the variability of psychometric quality for different measurements (Svartdal and Steel, 2017). In addition to this field, results based by heterogeneous measuring tools were found in elsewhere (Dawis, 2000; Marsh et al., 2013). In this vein, it lead us to assume that the conflicting results may be moderated by different scales. Further, procrastination type is also noteworthy to be an alternative moderator. On the basis of temporal motivation theory, the main factor to promote one postponing off is the inadequate motivations (Steel, 2007). A robust body of studies provided solid evidence to claim the interaction effect of gender and motivation, which demonstrated that female posed high intrinsic motivation than male in academic activities (e.g., reading, L2 learning, Rusillo and Arias, 2004; Kissau, 2006; Hakan and Münire, 2014). Despite no straightforward evidence, such interaction may bring about the specific sex-differences between academic procrastination and other ones. Lastly, the educational stage stress should be taken into account to explain the heterogeneous results for sex-differences in procrastination. It is well-known to us for the close association between perceived stress and procrastination, with more stresses for stronger procrastination tendency (Stead et al., 2010; Sirois and Tosti, 2012). On the other hand, more stresses were perceived for students in high educational stages than others, and make undergraduates more prone to procrastinate (Pascoe et al., 2020). Given the significant gender-difference (Barnett et al., 1987), we are interested in probing into how the educational stage may influences procrastination and even the interaction of gender and procrastination.

In the current study, we aim to integrate the results of previous studies of the relationship between procrastination and gender, SES, cultural differences, and educational background and to identify factors that influence their relationship. As aforementioned, we hypothesize that the males may procrastinate more than females. In addition, participants with low SES, western cultural contexts, or majoring in arts may be incline to procrastinate than others. Further, we assumed that the association between procrastination and these demographic architectures would be moderated by measurements/types of procrastination and educational stages.

MATERIALS AND METHODS

Participants and Study Design

This study aimed to investigate the sociodemographic characteristics of procrastination by using a meta-analysis that included gender, socioeconomic status, multiculturalism, family size, and educational background. All the types of procrastination would be in the scope of the current study, such as general procrastination, academic procrastination and decision-making procrastination. Taking into account potential moderated variables or hierarchical natures, the sub-meta-analysis and moderation analyses were used to probe whether these effects were moderated by measurements, procrastination

types or other factors. Finally, jackknife analysis was used to validate the robustness of the pooled meta-analytic effects. On balance, this study strove to demonstrate the sociodemographic characteristics of procrastination and unveil the factors that may moderate these effects. This study has been approved by Institutional Review Board (IRB) of Faculty of Educational Science, Sichuan Normal University (China).

Systematic Meta-Analytic Protocol

The protocol for performing the sociodemographic meta-analysis in the current study was preregistered in the Open Science Framework (OSF) repository beforehand[1]. This study fully adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for literature searching and data extraction (see **Supplemental Information**).

Data Source and Search Strategy

The databases to be searched to acquire meta-analytic data were Web of Science (WoS), Science Direct (Elsevier), ProQuest, and Google Scholar. In addition to these international databases, Chinese academic databases were screened as well, including the China National Knowledge Infrastructure (CNKI)[2], Wangfang[3], Vip Consult Center[4] and China Biology Medicine disk (CBMdisc[5]). Searches in these databases were limited to peer-reviewed empirical research published from Jan 2000 to Jan 2021. Despite lack of peer review, dissertations for the full-time Chinese doctoral and master's degrees were also included in the preliminary data pool once they were determined to be eligible by a modified Newcastle-Ottawa quality assessment (see more details below). Studies published in preprint form were excluded from the data pool for meta-analysis.

Retrieval Procedure

As a strikingly productive tool, Boolean logic expression (BLE) was drawn upon for literature retrieval. To avoid missing the target, no elimination operator was used in the search. The full search expression in searching the international databases was as follows: (procrastination OR procrastinator OR procrastinate) AND (gender OR sex) OR (socioeconomic status) OR (country OR Han) OR (family size OR single child OR double child) OR (education OR educational backgrounds OR STEM). Likewise, such BLE was also adopted to retrieve target studies in the Chinese databases using Mandarin. To cover all the alternatives for, no exclusion criteria were used in the first searching procedure. Furthermore, to strengthen the search accuracy, the elimination operator was used for re-retrieval. Finally, reference tracking to a hub paper that was cited frequently was undertaken to validate the convergence of this retrieval, such as Steel (2007) and Steel and Ferrari (2013). Specifically, the references cited in hub papers would be reviewed manually, one by one, to validate whether there were missing target papers and to scrutinize whether these potential papers were worth checking for eligibility in the current study.

Inclusion and Exclusion

To screen available studies for quantitative meta-analysis, the inclusion and exclusion criteria are given here. First, the aims of the screened study should be in line with those of the current study. That is, papers seeking to build upon the link between procrastination and sociodemographic features could be included. Second, these studies should provide adequate effect sizes for meta-analyses, including t values, sample sizes, and descriptive sample information. Third, the procrastination should be measured by widely-used or board-certified scales (e.g., general procrastination scale, and pure procrastination scale). Thus, these studies measuring procrastination from self-made questionnaire or self-report interview would be excluded. Last, the minimum sample size was limited to 30 in each included study to ensure statistical power.

Data Extraction, Data Coding and Statistics

On the basis of PRISMA protocol, the fundamental information and data were extracted by two independent researchers, including the authors, title, t-statistics, moderators, measurements, and sample size. Further, data coding was performed independently by them. Subsequently, they exchanged data extraction and coding records, and further re-did these procedures to examine for inconsistent results. Finally, once these data were checked for no errors, one researcher inputted them into the CMA software, and another one would double-check whether there were typo independently to validate the correctness of pooling effect size.

Comprehensive meta-analysis (CMA, V3.1) was drawn for meta-analytic statistics in the current study. First, the raw t-statistic (i.e., t-value and sample size) for each included study was estimated for the weighted r value and corresponding 95% confidence intervals (CI). Furthermore, all the estimated r values were pooled into either a fixed-effect model (FEM) or random-effect model (REM), which was determined by the heterogeneity of the data pool. In this vein, I^2 and Q^2 tests were used to evaluate the between-study heterogeneity, with $< 20\%$ for low variation, 50% for medium variation and 75% for high variation. A FEM should be adopted if low or medium heterogeneity is detected, while an EFM should be more suitable when high heterogeneity is found (Borenstein et al., 2011). Given the adverse effects of publication bias, Egger's test and fail-safe N tests were performed to estimate the effects of potential publication bias, with statistical significance in Egger's test at $p < 0.05$ and $N > 5k + 10$ for predominant publication bias (Fragkos et al., 2014). In addition, the jackknife test was adopted to validate the robustness of the meta-analytic results (Radua and Mataix-Cols, 2009; Frodl and Skokauskas, 2012). This process adopted a leave-one-paper-out (LOPO) scheme to iterate the meta-analysis and further examine whether the targeted significant effects could be maintained.

[1]https://osf.io/c928r/

[2]http://www.cnki.net

[3]http://www.wanfangdata.com.cn

[4]http://www.cqvip.com/

[5]http://www.sinomed.ac.cn/

Jackknife Analysis and Newcastle-Ottawa Quality Assessment

The Jackknife analysis is to examine the robustness of meta-analytic results by using iteration procedure. In detailed, the meta-analysis would be redone by removing one study included in the datapool, subsequently. This procedure would be iterated until each one was removed once. If the significance of results for all the iteration kept consistent with this meta-analysis, these results would be considered robust enough. Meanwhile, the Newcastle-Ottawa quality assessment was developed to examine the quality of included studies, including five items: balanced gender ratio, sample size, validity, and quality of scales. More details can be found elsewhere (Wells et al., 2014).

RESULTS

All the coding data and unfolded documents (results) have been uploaded to the OSF repository (see text footnote 1) to promote reproducibility and transparency.

Included Study and Fundamental Information

On the basis of PRISMA protocol, we attempted to search studies on gender-differences in procrastination, and a total of 20,552 studies were retrieved. Afterward, 13,622 studies were retained after duplication checks. Furthermore, 8,755 studies were removed as they fell outside our research aims (e.g., literature review, opinion article) when screening abstracts. Full-text examination was conducted to determine the eligibility of these 3,324 studies. Last, 193 studies were ruled out for formal quantitative meta-analysis because of either a lack of statistical information or non-standardized measurements. In summary, this final meta-analytic model included 193 papers concerning general and academic procrastination (n = 102,484) (for more details, see **Figure 1**). Notwithstanding that, it is unexpected that the vast majority of included studies is derived from mainland China (k = 13 and n = 3,146 for other countries, k = 180 and n = 97,604 for Chinese population). Thus, the sample bias should be mentioned for the following analyses. Other meta-analytic models for socioeconomic status, country, family size, and educational background can be found in the SI.

Synthesized Main Findings

Males Procrastinate More Than Females

A total of 193 papers (k = 193) were included to pool effects for revealing gender differences in both general and academic procrastination, with 102,484 participants [47,901 males (46.73%), 54,583 females (53.27%)]. The findings derived from both Q and I^2 tests showed a high level of between-study heterogeneity [Q (192) = 1,266.78, $p < 0.001$, $I^2 = 84.84$] and thus indicated that the REM is more suitable here. The REM results demonstrated that the procrastination tendency was significantly higher in males than in females (r = 0.042, 95% CI: 0.023–0.056, z = 4.785, $p < 0.001$) (see **Supplementary Table 1** and **Figure 2**). No publication bias was found in this meta-analysis (Egger's test t = 0.38, p = 0.70; Begg test tau = 0.02, p = 0.65; fail-safe N = 7,226) (see the funnel plot in **Supplementary Figure 1**). The results of the modified Newcastle-Ottawa quality control assessment demonstrated good quality for the included studies and showed high scorer reliability based on the Spearman test (Qs = 4.48, r = 0.99, $p < 0.001$) (see **Supplementary Table 1**).

No Significant Differences in These Procrastination Tendencies Based on Socioeconomic Status

Forty papers (k = 40) were pooled into a meta-analytic model to probe whether there were differences in procrastination tendencies based on socioeconomic status [N = 21,478; 9,540 males (44.41%), 11,938 (55.59%)]. As the between-study heterogeneity was quite high, the REM was adopted for this meta-analysis [Q (39) = 106.74, $p < 0.001$, $I^2 = 63.43$]. The results revealed no significant effects of socioeconomic status on procrastination tendencies (r = 0.019, 95% CI: −0.004–0.041, z = 1.627, p = 0.104) (see **Figure 3** and **Supplementary Table 2**). No significant publication bias was found in this meta-analytic model according to Egger's test and fail-safe N test (Egger's test t = 0.56, p = 0.57; Begg test tau = 0.005, p = 0.962; fail-safe N = 36) (see the funnel plot in **Supplementary Figure 2**). The included studies were observed to be of good quality on the basis of a modified Newcastle-Ottawa quality control assessment (Qs = 4.53, r = 1.00, $p < 0.001$) (see **Supplementary Table 3**).

No Significant Multicultural Differences in These Procrastination Tendencies

It should be noted that only Chinese populations were included for this meta-analysis aiming at the cultural differences in procrastination. As the majority and minorities of China posed independent cultures, participants in different ethnic group were considered to undergo different cultural contexts in the current study. Thus, these results derived from this analysis should be considered exploratory and primary. By comparing procrastination between majority and minorities, the six papers (k = 6) were included in the meta-analysis to clarify whether procrastination tendencies would vary with respect to multicultural contexts [N = 3,091, 1,047 males (33.87%), 2,044 females (66.12%)]. No significant between-study heterogeneity was found in this meta-analysis [Q (5) = 9.02, p = 0.108, $I^2 = 44.57$]. Instead of the REM, the FEM was deployed to estimate the total effects, and a null finding was revealed (r = 0.002, 95% CI: −0.048–0.050, z = 0.055, p = 0.956) (see **Figure 4** and **Supplementary Table 4**). No significant publication bias was found in this model, either in Egger's test or in the fail-safe N test (Egger's test t = 0.44, p = 0.68; Begg test tau = −0.33, p = 0.452; fail-safe N = 0) (see the funnel plot in **Supplementary Figure 3**). Likewise, all the included studies were assessed as eligible (Qs = 3.71, r = 0.80, $p < 0.05$) (see **Supplementary Table 5**).

No Evidence to Support the Impact of Family Size on These Procrastination Tendencies

To gain further insights regarding the roles of family size in procrastination tendencies, 61 studies were included in the meta-analytic model. Both Q and I^2 tests were performed to detect

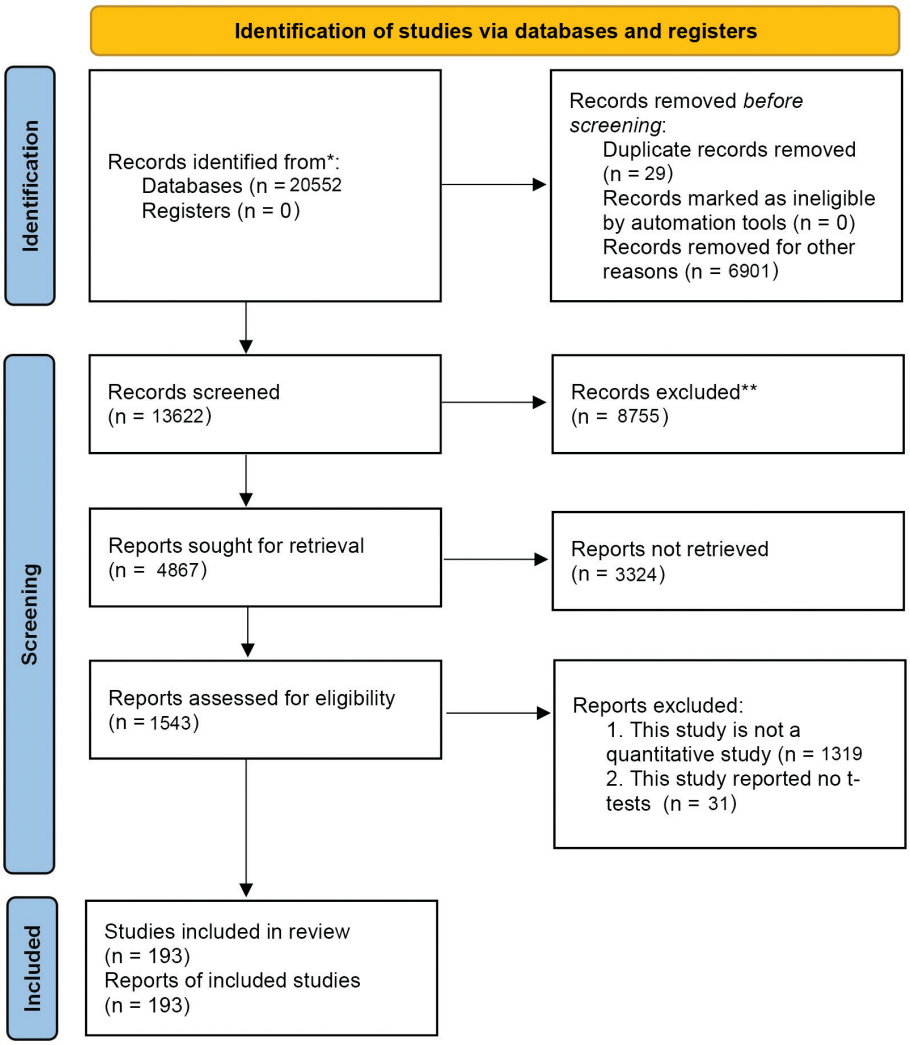

FIGURE 1 | PRISMA 2020 flow diagram for the current meta-analysis.

potential between-study heterogeneity, and the results indicated that the REM is more suitable [Q (60) = 182.25, $p < 0.001$, $I^2 = 67.08$]. Thus, the REM was used but yielded a null finding ($k = 61$, $r = 0.011$, 95% CI: −0.008–0.031, $z = 1.122$, $p = 0.262$) (see **Figure 5** and **Supplementary Table 6**). Additionally, there was no significant publication bias in this meta-analytic model (Egger's test $t = 1.19$, $p = 0.23$; Begg test tau = 0.08, $p = 0.347$; fail-safe $N = 0$) (see the funnel plot in **Supplementary Figure 4**). All the included studies were well validated in terms of quality (Qs = 4.52, $r = 1.00$, $p < 0.001$) (see **Supplementary Table 7**).

No Significant Differences in These Procrastination Tendencies Based on Educational Background

In the current study, educational background was divided into two types: literature/arts and science. To reveal whether this sociodemographic feature could lead to differences in procrastination tendencies, 42 papers ($k = 42$) were used for a meta-analysis. As between-study heterogeneity was high, the REM was thus used for pooling total effects [Q (41) = 440.05, $p < 0.001$, $I^2 = 90.68$]. The results showed a null effect for this association ($r = -0.010$, 95% CI: −0.055–0.034, $z = -0.46$, $p = 0.643$) (see **Figure 6** and **Supplementary Table 8**). As examined by Egger's and fail-safe N tests, no significant publication bias existed in this model (Egger's test $t = 0.37$, $p = 0.70$; Begg test tau = −0.03, p = 0.76 fail-safe $N = 0$) (see the funnel plot in **Supplementary Figure 5**). The included studies were well validated in terms of quality (Qs = 4.62, $r = 0.99$, $p < 0.001$) (see **Supplementary Table 9**).

Synthesized Results of Moderated and Sub-Group Analysis

Gender Difference Was Moderated by Various Measurements

High between-study heterogeneity has long been acknowledged to be implicated to potential moderators. In this vein, the

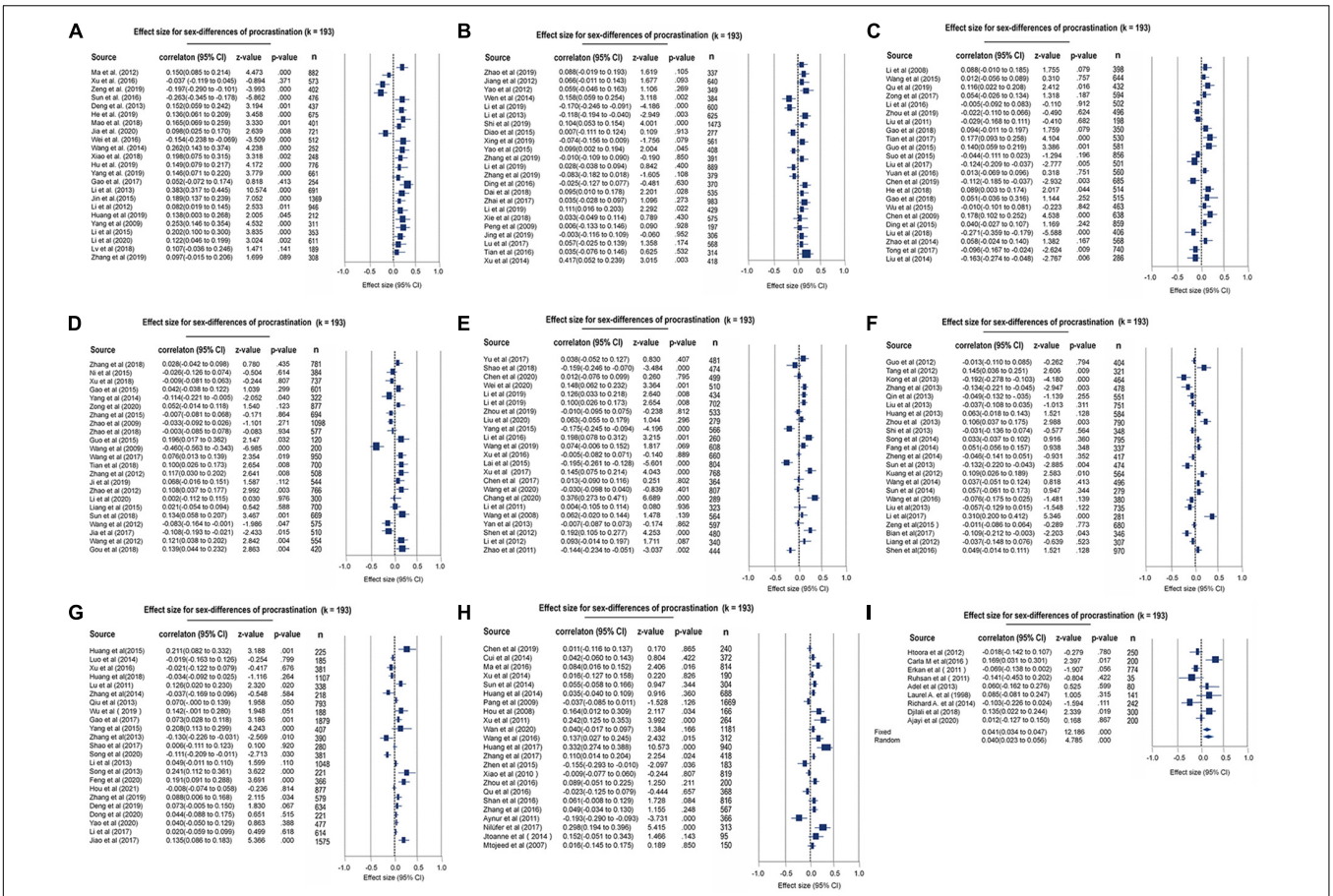

FIGURE 2 | Forest plot for the meta-analytic results toward gender differences of procrastination.

current study conducted moderated analysis by using mixed effects analysis. Results indicated that the gender difference of procrastination tendency was moderated by various measurements significantly (point estimate = 0.042, 95% CI: 0.027–0.057, z = 5.474, p < 0.001). Sub-group analysis was conducted to clarify this moderated effects, and showed the high gender differences effects in Aitken Procrastination Inventory (API, point estimate = 0.035, 95% CI: −0.011–0.081), The Procrastination Assessment Scale–Students (PASS, point estimate = 0.056, 95% CI: 0.029–0.083), and the Academic Procrastination Questionnaire—Middle School Student (APQ-MSS, point estimate = 0.072, 95% CI: 0.031–0.112), as well appeared low effects in General Procrastination Scale (GPS, point estimate = 0.018, 95% CI: −0.019–0.056) and Tuckman Procrastination Scale (TPS, point estimate = 0.026, 95% CI: −0.027–0.078).

Gender Differences Had a Stronger Effect on Academic Procrastination Than on General Procrastination

Further moderated analysis revealed the moderating role of procrastination types, including academic procrastination and general procrastination (point estimate = 0.042, 95% CI: 0.026–0.058, z = 5.139, p < 0.001). Subgroup analysis demonstrated prominently larger effects on academic procrastination (point estimate = 0.047, 95% CI: 0.030–0.065) than on general procrastination (point estimate = 0.019, 95% CI: −0.019 to −0.057).

Graduate Students Showed Stronger Gender Differences Related to These Procrastination Tendencies

As large effects on academic procrastination were found, we performed a sub-sub-meta-analysis to probe whether such effects would be moderated by the different stages of education, including primary school, junior school, high school, undergraduate and postgraduate levels. The results illustrated the significant moderating effects of educational stages on gender differences related to procrastination tendencies (point estimate = 0.041, 95% CI: 0.026–0.056, z = 5.300, p < 0.001). Further *post hoc* analysis demonstrated larger effects for undergraduate students (point estimate = 0.040, 95% CI: 0.018–0.062) and graduate students (point estimate = 0.138, 95% CI: 0.027–0.246) than students of other education levels (see **Table 1**).

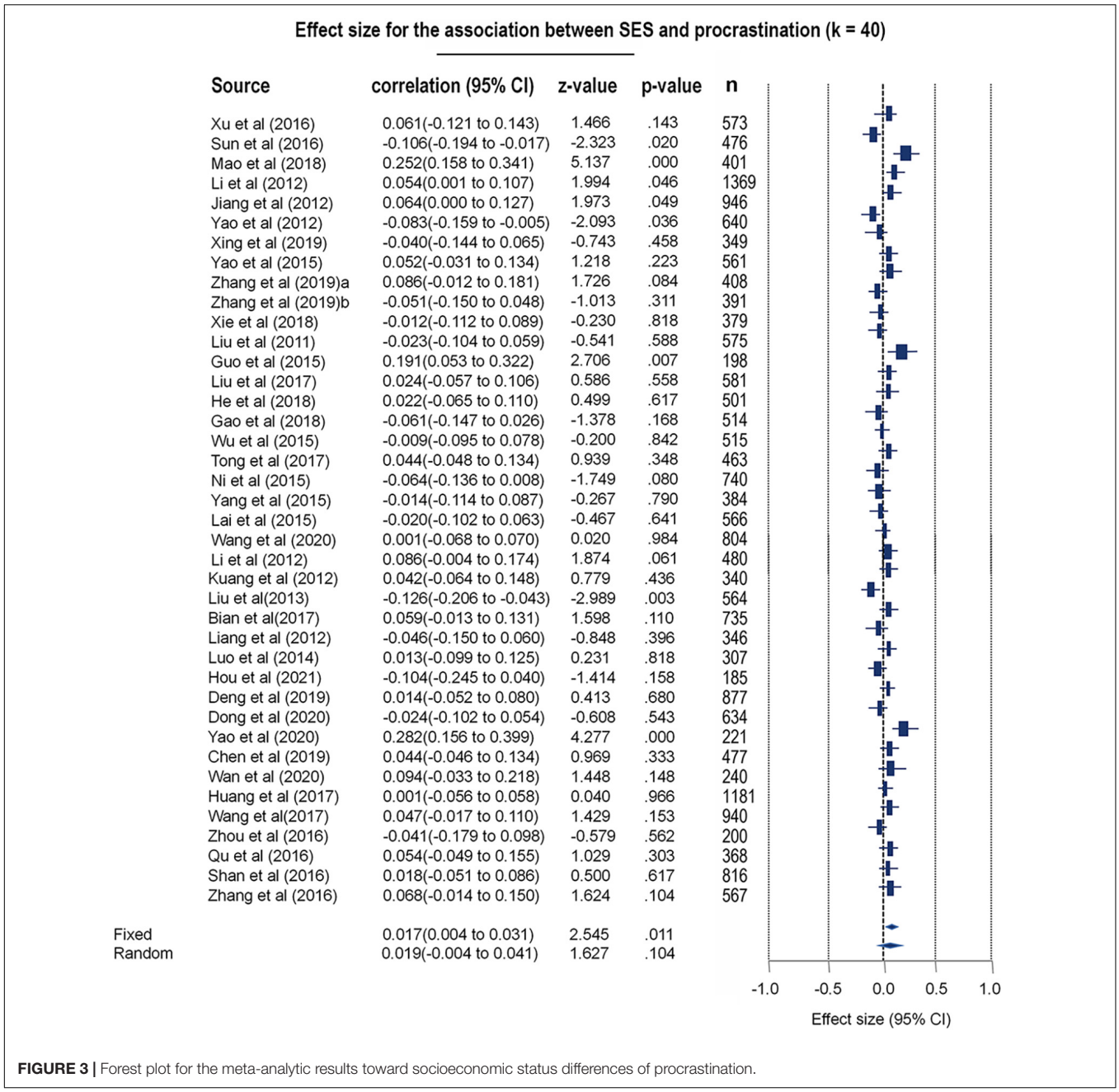

FIGURE 3 | Forest plot for the meta-analytic results toward socioeconomic status differences of procrastination.

Results of Jackknife Examination of Robustness

All the statistical results were validated to pass the jackknife test for examining robustness, showing no outliers (see **Supplementary Table 10**).

DISCUSSION

The current study performed sociodemographic meta-analyses to synthesize the results of previous studies on the relationship between general/academic procrastination and gender, SES, cultural differences, and educational background, and to explore potential factors that affect this relationship. By including 193 quantitative studies with 102,484 participants, the results showed that the males procrastinate more than females with moderate effect size ($r = 0.042$, 95% CI: 0.023–0.056, $z = 4.785$, $p < 0.001$) for general and academic procrastination. In addition, by using a small sample size ($n = 21{,}478$, $k = 40$ for SES; $n = 3{,}091$, $k = 6$ for multi-cultural contexts; $n = 32{,}096$, $k = 61$ for family size; $n = 21{,}767$, $k = 42$ for educational stage), no significant effects were found to support the sociodemographic association between procrastination and SES, multi-cultural contexts, family size, educational stage ($r = 0.02$, $p = 0.10$

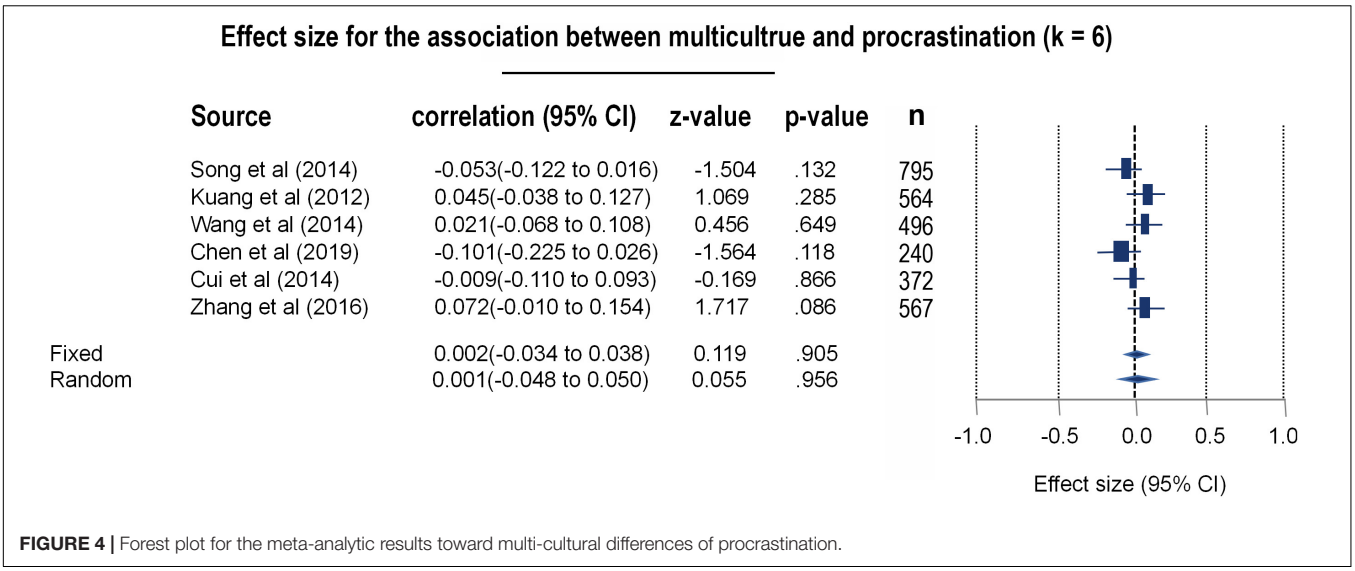

FIGURE 4 | Forest plot for the meta-analytic results toward multi-cultural differences of procrastination.

for SES; $r = 0.002$, $p = 0.97$ for multi-cultural contexts; $r = 0.01$, $p = 0.26$ for family size; $r = -0.01$, $p = 0.64$ for educational stage). Further, we found that various measurements of procrastination, procrastination types, and educational stages significantly moderated this relationship ($Q = 0.04$, $p < 0.001$ for different measurements; $Q = 0.04$, $p < 0.001$ for procrastination types; $Q = 0.04$, $p < 0.001$ for educational stages). *Post hoc* analysis demonstrated the high effect size for gender-differences of procrastination in API ($Q = 0.035$, $p < 0.001$) and PASS ($Q = 0.056$, $p < 0.001$) and revealed the low effect size by using GPS ($Q = 0.018$, $p > 0.05$) and TPS ($Q = 0.026$, $p > 0.05$). Also, the effect size for gender-differences of procrastination was found in academic procrastination ($Q = 0.042$, $p < 0.001$) compared to general procrastination ($Q = 0.019$, $p > 0.05$). Lastly, graduate students were found higher effect size than others significantly ($Q = 0.138$, $p < 0.001$). Thus, this study could lead us to draw a conclusion that males procrastinate more than females in both general and academic procrastination, especially in Chinese contexts. Further, this relationship may be moderated by the measurements, type of procrastination and academic status in the almost Chinese samples. Further, this relationship may be moderated by the measurements, type of procrastination and academic status. On the other hand, by using small-size samples, there were no enough evidence to claim the sociodemographic association of procrastination for SES, multi-cultural contexts, family size and educational stages.

Gender Is Significantly Correlated With General and Academic Procrastination

In particular, this study provided robust statistical evidence that males procrastinate more than females ($n = 102{,}484$, $k = 193$; $r = 0.042$, 95%, $p < 0.001$) in both general and academic procrastination, which was consistent with previous investigations suggesting a relationship between them (Pychyl et al., 2000; Steel, 2007; Gröpel and Steel, 2008). There might be promising evidence suggesting a causal role of demographic features (i.e., gender) in procrastination. Males were found to possess a lower level of self-control, which is a key determinant of procrastination (Tewksbury and Higgins, 2006; Ward et al., 2018). As a result, males may tend to procrastinate more due to a lack of goal-directed processing ability and an inability to suppress tempting stimuli (Pychyl et al., 2000; Ferrari, 2001; Steel, 2007; Steel and Klingsieck, 2016). Similarly, males also have a higher level of impulsivity than do females (Cross et al., 2011). A large number of studies have demonstrated that procrastination is positively associated with impulsivity from the behavior, neural variance and behavioral genetics perspectives (Steel and König, 2006; Gustavson et al., 2014; Liu and Feng, 2017), suggesting that males may procrastinate more than females as a result of intrinsic neurobiological factors. Furthermore, a previous meta-analysis found that females score higher on effortful control than males and that effortful control is closely related to procrastination as well (Else-Quest et al., 2006; Lian et al., 2018). This may explain why females procrastinate less than males. On the other hand, existing studies have provided insights into the evolutionary origins of procrastination, suggesting that procrastination can be considered a strategy frequently used throughout life to deal with unpredictable circumstances (Steel, 2007; Chen and Chang, 2016; Chen and Qu, 2017). Compared to females, males were identified to be more sensitive to unpredictable environments, in which they are able to adapt and quickly develop a strategy to succeed using their past experience (Del Giudice, 2009; Jonason et al., 2017). Thus, males' procrastination tendencies may be stronger than those of females as an evolutionary consequence. Notwithstanding that, the external ecological validity should be mentioned to discuss above results. Notably, there were no any statistical considerations aiming at the ecological validity of this meta-analysis though the substantial heterogeneity for these included studies was found (Andrade, 2018). Despite statistical significance, above explanations to support our findings that the males procrastinate more than females were largely

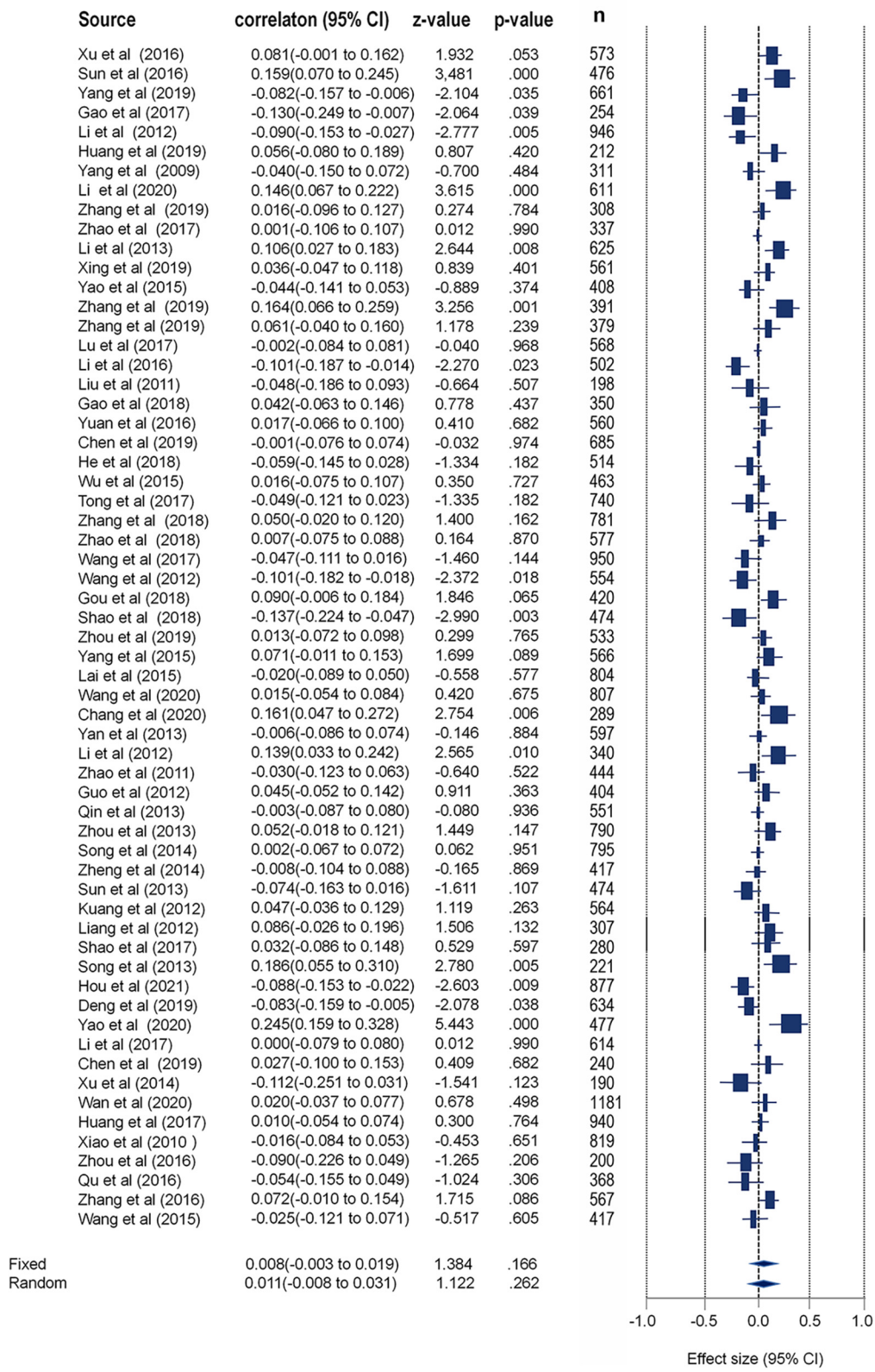

FIGURE 5 | Forest plot for the meta-analytic results toward family size differences of procrastination.

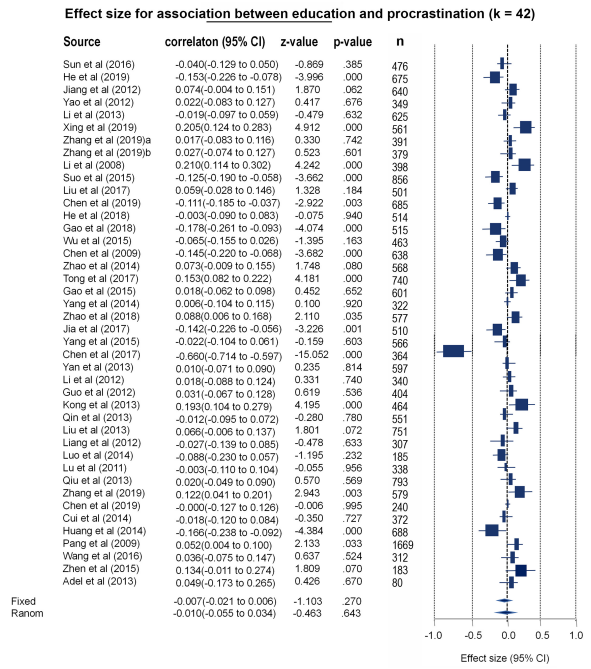

FIGURE 6 | Forest plot for the meta-analytic results toward educational background differences of procrastination.

grounded *post hoc* evidence. There were evidence not enough to validate whether this conclusion could be generalizable elsewhere. Given that, extending this conclusion should be quite careful. On balance, the results demonstrated that males procrastinate more than females, not only because of their low levels of self-control and effortful control and high levels of impulsivity but also because of human evolutionary influences.

Null Findings Were Observed for the Association Between Procrastination and SES, Multicultural Differences, Family Size and Educational Background

However, the hypotheses in present study has not been fully confirmed. For instance, no significant correlation was found between SES and procrastination in the limited sample size ($n = 21{,}478$, $k = 40$, $r = 0.02$, $p = 0.10$). One possible explanation is that SES mediates procrastination through other factors, such as parenting style and self-efficacy (Wäschle et al., 2014). Another explanation may be that the high heterogeneity confounded the meta-analytic effects as unaccountable random factors. In addition, the results showed no significant correlation between multicultural differences and procrastination. As reviewed by Steel (2007), procrastination is a personality-like trait and is relatively stable in cross-cultural contexts. Furthermore, there was no significant association between family size and procrastination. On the one hand, procrastination may manifest in postponing childbirth (Steel, 2010b; Steel and Ferrari, 2013; Schippers et al., 2015), which may complicate the association between procrastination and the number of children. On the other hand, unplanned pregnancies are associated with impulsiveness, which is a strong predictor of procrastination (Kahn et al., 2002). Thus, we posited that the association between family size and procrastination may develop in a more complicated, non-linear manner. In addition, no correlation was found between educational background and procrastination, which was consistent with previous research suggesting that majoring in liberal arts or science is not a determinant of procrastination (Seker, 2015). Collectively, despite the failure to validate all the hypotheses, the current study provides robust meta-analytic evidence to substantiate the association between gender and procrastination.

Heterogeneous Psychometric Tools, Types and Educational Stages Biased the Conclusion Regarding the Association Between Gender and Procrastination

Existing studies have not well established the connection between gender and procrastination. Some studies demonstrated that gender was significantly correlated with procrastination (Gröpel and Steel, 2008), while others revealed a null correlation between them (Ferrari, 1989; Ferrari et al., 2005b). Thus, it is valuable to explain why there were different results for the association between procrastination and gender. To this end, the current study performed moderation analysis to clarify the potential factors resulting in inconsistent results. The results of the moderation analysis showed that the heterogeneity in the measurement tools, procrastination types, and educational stages could moderate the association between gender and procrastination.

First, the current study noted the different sensitivity levels of tools for measuring procrastination, with strong effects for the association between gender and procrastination in terms of API, PASS and APQ scores and weaker effects on GPS and TPS scores. Thus, to obtain reliable results, widely used, revised and well-established scales or questionnaires, such as the GPS and PPS (i.e., pure procrastination scale), should be adopted. In addition, the psychometric properties of different scales should be validated robustly before attempting to measure procrastination. Despite the solid theoretical basis, there was weak evidence to support the psychometric robustness of some of the scales.

Another important finding derived from this sub-meta-analysis was that the observed association between procrastination and gender was influenced by procrastination type, with the largest effects on academic procrastination. It has been suggested that females show a fear of strangers and unfamiliar events at an earlier age than males (Archer, 1991). Additionally, female students tend not to procrastinate in their academic tasks because of a fear of achieving low course grades (Özer et al., 2009). On the other hand, male students more frequently reported that they procrastinated in

TABLE 1 | Summary of moderated effects of identity for the association between gender and procrastination.

Groups	Number Studies	Effect size and 95%interval			Test of null (2-tail)		Heterogeneity		
		Point estimate	Lower limit	Upper limit	*Z*-value	*P*-value	Q-value	df(Q)	*P*-value
Adult	3	0.039	−0.043	0.121	0.931	0.352			
College student	95	0.040	0.018	0.062	3.592	0.000			
Graduate	9	0.138	0.027	0.246	2.427	0.015			
High school	18	0.080	0.042	0.117	4.167	0.000			
Junior school	37	0.022	−0.012	0.056	1.280	0.200			
Primary school	31	0.004	−0.044	0.052	0.165	0.869			
Total between							10.599	5	0.060
Overall	193	0.041	0.026	0.056	5.300	0.000			

their studies due to risk taking and resisting control (Lippa, 2002). In addition, male students are more impulsive than adults, suggesting that they may be more inclined to delay academic tasks (Steinberg et al., 2008; Duckworth et al., 2013). One more alternative explanation worthy to note that the procrastination type moderated the gender-difference of procrastination by age. Beutel et al. (2016) provided solid evidence to demonstrate that the gender-differences of procrastination were found only in the young population (ages from 14 to 29) instead of the overall large-scale sample (Beutel et al., 2016). It may indicate that the academic procrastination was frequently found in young students and it thus let the gender-differences of procrastination more obvious than others. Overall, these findings may indirectly indicate that gender differences more strongly affect general procrastination than academic procrastination.

Last, the sub-meta-analysis further revealed that the observed relationship between procrastination and gender is influenced by educational stage, and the influence of undergraduate students is stronger than that of students at other levels. Previous studies have suggested that undergraduate/graduate students procrastinate more than high school or primary school students, because undergraduate/graduate students have more freedom in terms of time and content to complete academic tasks than high school students do (Milgram et al., 1993; Özer and Saçkes, 2011). Thus, compared to students at other educational stages, undergraduate students were likely to be influenced by more distractors and devalued the utility of rewards for completing academic tasks, which made those students more inclined to procrastinate. Additionally, taking into account neuroendocrine factors, females are more fearful and avoidant than males as part of hormonal factors in the late teens (Coates and Wolfe, 1995). In this vein, as procrastination has been proven to be correlated with avoidant motivation (e.g., Steel, 2007, 2010a), the moderating role of educational stage on the association between gender and procrastination could be explained by the neuroendocrine variation between males and females.

Limitation and Future Directions

Although this study here revealed demographic characteristics of procrastination, several limitations should warrant cautions. It is worthy to note that a portion of meta-analyses just included the limited number of existing studies, such as the cross-cultural differences of procrastination. Thus, given the marginal sample size, these conclusions should be preliminary and exploratory, as well should be interpreted more cautiously. Another one should bear in mind that the included studies mainly focus on Chinese population (93%). Given the significant sample biases, it should warrant some cautions when these conclusions would be extended elsewhere. Also, it is merit to test the generalizability of the current study in more diverse samples. It is worthy to note that a portion of meta-analyses just included the limited number of existing studies, such as the cross-cultural differences of procrastination. Further, the robustness of results that derived from cross-cultural differences was challenged by sample representation as well. Taken both reasons together, the conclusions for this analysis should be preliminary and exploratory, as well should be interpreted more cautiously. In addition, we found considerable heterogeneity in these meta-analyses. Although we discovered some moderating factors, more factors are worth studying to account for this heterogeneity. Furthermore, the sample representation was somewhat inadequate (e.g., much more Chinese participants than others), which suggests the need for future research using a representative sample to achieve unbiased results. Lastly, as limited by existing literature, it lacks a portion of types of procrastination in meta-analytic model, such as bedtime procrastination and health procrastination. Thus, it is merit to include multiple procrastination types for providing more robust evidence in future study.

CONCLUSION

In summary, this meta-analysis suggested that males procrastinate more than females. In addition, the current study revealed no significant association between procrastination and other sociodemographic features, including socioeconomic status, cultural differences, family size and educational background. Overall, the main strength of our meta-analysis study yields insights into the sociodemographic characteristics of procrastination and the factors that may moderate these effects. Given the association between procrastination and societal ailments (e.g., delayed medical treatment), identifying sociodemographic characteristics associated with procrastination would be valuable for directing public policies aimed at prevention.

DATA AVAILABILITY STATEMENT

All the raw data, scripts, figures and materials can be accessible at OSF repository (https://osf.io/c928r/).

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by IRB of Faculty of Educational Science, Sichuan Normal University (China). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DL: conceptualization, methodology, software, writing—original draft and visualization, supervision, project administration, and funding acquisition. YH and YT: writing—review and editing, methodology, and validation. 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.2021.719425/full#supplementary-material

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Self-Regulation of Slippery Deadlines: The Role of Procrastination in Work Performance

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We investigated the causes and impact of procrastination on "slippery deadlines," where the due date is ill-defined and can be autonomously extended, using the unique applied setting of grievance arbitration across two studies. In Study One, using 3 years of observed performance data derived from Canadian arbitration cases and a survey of leading arbitrators, we examined the effect of individual differences, self-regulatory skills, workloads and task characteristics on time delay. Observed delay here is a critical criterion, where justice is emphasized to be *swift* and sure. Multilevel Modeling established trait procrastination as a substantive predictor of observed delay, equivalent to the environmental contributors of expediting the arbitration procedure or grievance complexity. Also, despite substantive negative consequence of delay for both arbitrators and their clients, arbitrators who scored one standard deviation above the mean in procrastination took approximately 83 days to write their decisions compared to the 26 days for arbitrators one standard deviation below the mean. In Study Two, we conducted a replication and extension survey with a much larger group of American arbitrators. Consistent with Temporal Motivation Theory (TMT), trait procrastination was largely explained by expectancy, value, and sensitivity to time related traits and skills, which together accounted for majority of the variance in trait procrastination, leaving little left for other explanations. For example, perfectionism connection to procrastination appears to be distal, being largely mediated by each of TMT's core variables. Finally, procrastination was largely synonymous with a deadline pacing style, indicating that observed delay can be used as a proxy for procrastination as long as little or no prior work was done (e.g., a u-shaped pacing style is not synonymous). In all, our results indicate that procrastination is rampant in the workplace and has seriously detrimental effects.

Keywords: procrastination, motivation, dynamic, time, delay, arbitration

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INTRODUCTION

Procrastination is an enduring vice, with descriptions in ancient Egypt and Greece dating to the invention of the written word (Benderitter, 2011). Today, procrastination is endemic, with chronic procrastination rising from 5% of the population in the 1970s to approximately 30% in 2010 (Steel and Ferrari, 2013), that is scoring four or higher on a five-point scale. This is notable

because procrastination is inherently an irrational or a self-defeating behavior. By definition, we procrastinate when we voluntarily put off until later what we think we should be doing now despite expecting the worse for our delay. More broadly, it reflects an intention-action gap, were we leave actions past their optimal starting date (van Hooft et al., 2005). A review by Steel (2011) confirms what procrastinators suspected, that the ramifications of their delays are indeed typically negative, from health to wealth to happiness. For example, the average income difference between those who report minimal versus maximal procrastination approaches $60,000 per year (Nguyen et al., 2013). Similar, patients failing to comply with medical advice has long been a serious issue, with procrastination singled out as a significant contributor (Becker and Maiman, 1975). Reflecting its deleterious impact and increased prevalence, Surowiecki (2010) notes that "the study of procrastination has become a significant field in academia, with philosophers, psychologists, and economists all weighing in" (p. 110).

Despite such prominence, as Sonnentag (2012) summarizes, "Time should be an important aspect of organizational theory, but it has been neglected for decades" (p. 1). This is expected as understanding why we procrastinate has been hampered by three methodological obstacles. First, there is choice of sample. Workplace procrastination is rife, with estimates that approximately a quarter of most people's working day can be characterized as procrastinating, with attendant productivity costs (D'Abate and Eddy, 2007; Steel, 2011). Yet, over 90% of studies are conducted with student samples and only about 1% focuses on employe samples (Steel, 2007). Student samples have provided rich data, with daily diary studies indicating students spend a third of their day putting off tasks (Pychyl et al., 2000), but the results do not always generalize to an adult working population (Sackett and Larson, 1990). In particular, the Attraction-Selection-Attrition (ASA) model indicates that those who procrastinate excessively could either not select, not be selected, or simply leave positions where their dillydallying is detrimental. Nguyen et al. (2013) work on job characteristics and procrastination supports this that is "jobs that require higher levels of motivational skills are less likely to retain procrastinators" (p. 388). Consequently, procrastination may not be as relevant to employers as it is to educators.

Second, the research in this area is predominantly mono-method, based almost exclusively on self-reports with only a few notable exceptions (e.g., Elvers et al., 2003; Reuben et al., 2015). To some extent, this reflects what is needed to operationalize the construct; since procrastination is an irrational delay according to one's own standards, it can only be inferred by an observer. Generally lacking is research that makes use of objective measures that can be examined alongside self-report measures. Furthermore, most of this research is concurrent instead of longitudinal, with the latter really required to assess the effects of delay. Even when it does rarely occur, as Roe (2014) reviews, motivational longitudinal research is often compromised, typically sampling only two or three time points for a short task. Instead, Roe suggests that we should deeply assess longer term projects favoring numerous time points over number of people, preferably all of whom are pursuing a similar goal. So far, only Steel et al. (2018) have managed to address all these specifications, including using an observed measure of delay, but still in an educational setting being based on a computerized Personal System of Instruction.

Third, most studies have focused on tasks with hard deadlines, including Steel et al. (2018), that is those with fixed due dates. Exams, essays and other assignments in academic courses predominantly use hard deadlines, with procrastinators doing an increasing amount of work as these deadlines approach. Business settings in contrast can have "slippery deadlines," where task completion is not fixed and can be autonomously extended further into the future. For example, where exams and essays often have unnegotiable deadlines, projects completion dates may be unspecified. It is unclear how hard deadlines compare to slippery ones. The dominant explanation of procrastination is temporal discounting (Steel, 2007, 2011), resulting in most work done when delay becomes small (i.e., before a deadline). With a slippery deadline, delay never necessarily diminishes and consequently the effects of temporal discounting is uncertain.

Due to this uncertainty, we do not know exactly how procrastination manifests in the workplace, particularly those with slippery deadlines. Previous reviews by Steel (2007, 2011) stress the importance of individual difference variables of impulsiveness, expectancy and value for predicting procrastination, but the degree they generalize to the workplace is unknown. As Nguyen et al. (2013) discuss, the workplace is often considered a strong environment which diminishes the strength of individual differences. Furthermore, employes may be selected or select themselves for the work environment, resulting in procrastination occurring typically in low-cost situations. For example, having intrinsic motivation for a task potentially eliminates the negative impact of impulsiveness as the reward is experienced while completing the task itself.

The Labor Arbitration Setting

To further investigate procrastination, we sought a Natural Decision Making (NDM) setting (Klein, 2008). As reviewed by Lipshitz et al. (2001), "NDM is an attempt to understand how people make decisions in real-world contexts that are meaningful and familiar to them" (p. 332). The NDM approach is descriptive (i.e., how people actually make decisions) rather than normative (i.e., a rational or ideal decision-making model) and, by studying people in their "natural habitat," it tests the degree to which laboratory findings generalize and are practically applicable, that is *external validity*. This approach also addresses the criticism that the applied psychological or organizational behavior field has a dearth of field research (Cialdini, 2009), with Baumeister et al. (2007) direct call for "a renewed commitment to including direct observation of behavior whenever possible and in at least a healthy minority of research projects" (p. 396). Ideally, in this setting individuals have autonomy over their work tasks, style, and pace. There must be a stock and flow of tasks needing attention, with incentives for completion of work. The dependent variable of time must be unobtrusively observed and accurately measured, with some consistency in task from person to person, and from product to product.

To this end, arbitrators are the ideal subjects. Labor arbitration is a widely adopted procedure to resolve disagreements about the application and interpretation of collective bargaining agreements (CBA) between unionized workers and their employers as well as the appropriateness of employe discipline (Bemmels, 1988; Bemmels and Foley, 1996; Trudeau, 2002; Ruben, 2003; Thornicroft, 2010). Under the model used in United States and Canada, employes who believe that a contractual term of their CBA has been violated can file a grievance alleging a contract violation and seeking a remedy. Most grievances are then subject to joint union-management discussion involving progressively higher levels of the respective organizations and most are resolved during such discussion (Lewin, 1999). Unresolved grievances are subject to arbitration.

Consequently, arbitrators produce written decisions that bring justice into the workplace, often juggling multiple cases while maintaining a regular pipeline of appointments. They must accept new cases while urgently trying to find time and energy to issue awards well past the dates of the actual hearings. Potentially, with arbitrators we can consider all three major sources of variability that could influence decision time: task characteristics, the work environment, and individual differences. Of particular interest is whether these individual difference variables remain relevant when taken out of the laboratory and examine in a NDM setting. We review each of these contributions in turn.

In an empirical study of labor arbitration cases using event history analysis, Ponak et al. (1996) divided the labor arbitration process into four distinct stages: (1) pre-arbitration grievance steps; (2) arbitrator selection; (3) hearing scheduling; and (4) preparation of the arbitration award (which we will refer to as "Decision Time"). This final stage accounts for approximately 20 percent of the overall elapsed time from the filing of the grievance to the arbitrator's decision (Steiber et al., 1985; Ponak and Olson, 1992). The first three stages are subject to the input of multiple parties, often with competing interests. The final stage, however, is almost entirely controllable by arbitrators and they have considerable discretion over Decision Time. Here, their autonomy is among the highest for any professional. They customarily work independently, have a great deal of control over their work scheduling, and over how to balance their work and private commitments. There are few deadlines except ones self-imposed, that is "slippery deadlines" in that they can be pushed ever forward into the future[1]. This makes their work environment not so strong that there isn't room for discretionary behavior (Mischel, 1977; Withey et al., 2005).

On the other hand, unnecessary delay is strongly discouraged. A body of literature exists on the sources of arbitration delay and there is a consensus that delay is increasing and is harming the labor relations system (Berkeley, 1989; Ponak and Olson, 1992; Thornicroft, 1995; Foisy, 1998; Lewin, 1999; Trudeau, 2002). More colorfully titled articles along this line include "The Well-Aged Arbitration Case" (Ross, 1958) and "Delay: The Asp in the Bosom of Arbitration" (Seitz, 1981). The parties to the arbitration anxiously await the decision, being consequential to grievances and to union-management relations. Furthermore, arbitrators feel an obligation to dispense justice quickly, being well aware of the adage "justice delayed is justice denied." An arbitrator's future acceptability may be harmed by a reputation for tardiness (Berkeley, 1989). There also is a financial incentive for arbitrators to work quickly toward a decision because the issuance of an award allows final billing to the parties. The National Academy of Arbitrators (NAA), the pre-eminent professional association of North American labor arbitrators, contains a section in its Code of Professional Responsibility devoted to "Avoidance of Delay" and arbitrators have been sanctioned for undue delay. Clearly, undue delay by an arbitrator is irrational.

A summary of arbitrator Decision Time reported averages ranging from 37 to 101 days depending on the time period covered and region (Thornicroft, 2010). These averages undoubtedly mask considerable variation from case to case, but most studies either report averages and medians without other statistics, or do not separate Decision Time from other parts of the process. The most comprehensive study of Decision Time and its predictors analyzed 500 arbitration decisions over a 4-year time period in the province of Alberta. It found a mean Decision Time of 65 days, a standard deviation of 56 days, and a maximum Decision Time of almost 1 year (Ponak et al., 1996). Notably, all previous studies that sought to explain Decision Time were based on content analysis of written awards, and scholars were able to explain less than one-third of the variance in Decision Time.

With the assistance of two co-authors, who are themselves highly placed within the arbitration community, we were able to comprehensively assess two groups of arbitrators, one Canadian and one American. Though the American sample has the advantage of being larger in size, in Canada, the law requires that all arbitration decisions be publicly reported and are available electronically. Critically, this reporting stipulation allows the Canadian sample to provide an unobtrusive measure of delay but also allows it to almost fully meet all of Roe (2014) suggested criteria for longitudinal studies (e.g., extended time, numerous points of assessment, common task). All data and analyses are available in an Open Science archive: https://osf.io/qsfht/?view_only=3a2144fa0d9d4a388197e33caddc825b.

THEORETICAL CAUSES OF ARBITRATORS' DELAY AND PROCRASTINATION

Given that this venue is uniquely suited to assessing procrastination with an *extremely* difficult to access sample of professional arbitrators whose individual differences have not been assessed before, making further study unlikely, we sought to comprehensively explore why delays occur. To this end, we considered broadly traits, self-regulatory skills, and situational influences that might account for the unexplained variance within each of our arbitration samples. As mentioned, the smaller Canadian sample is uniquely suited for depth (i.e., investigating tasks with multi-level modeling) and the larger

[1]Some collective bargaining agreements have specified time limits for rendering a decision, but such time limits are routinely waived by the union and employer.

American sample allows for cross validation and expansion of correlation findings.

Dispositional Traits Influencing Delay

Decision Time should be partially accounted for by motivational individual difference factors. Even when people have the capability, opportunity and intention for action, self-imposed delays can occur. Studied under a variety of terms depending upon the field, such as an "intention-behavior gap" (Sheeran, 2002), "value-action gap" (Barr, 2004) and "attitude-behavior consistency" (Crano and Prislin, 2006), people procrastinate due to individual differences, with procrastination itself appearing to be a personality trait as well. Enduring across time and situation, self-report procrastination has an average test-retest reliability after 42 days of 0.73 (Steel, 2007) and, like other personality traits, approximately 50% of the variance in trait procrastination is inheritable (Luciano et al., 2006). Here, we consider procrastination, expectancy, value, sensitivity to time, and perfectionism.

Procrastination

Arbitrators who score high on a trait procrastination scale should take longer to render their decisions. To explain why people procrastinate, Steel (2007) meta-analytic work found three major factors accounting for most of the variance: expectancy, value and time. These three factors form the basis of Temporal Motivational Theory (TMT), which has been applied specifically to procrastination. Accordingly, as *Expectancy* of success and the *Value* of the outcome increases, so does motivation. On the other hand, *Sensitivity to Time* creates hyperbolic discounting, in that the longer an outcome is delayed, the less our motivation. Those who are more sensitive to the effects of time, are distractible or have difficulty delaying gratification, tend to procrastinate more.

> *Hypothesis 1.1*: Arbitration decision time should be positively associated with trait procrastination.
>
> *Hypothesis 1.2*: Trait procrastination should be predominantly (i.e., at least 50% of the variance) predicted by expectancy, value, and sensitivity to time variables.
>
> *Hypothesis 1.3*: Trait procrastination should mediate the expectancy, value, and sensitivity to time variables relationships with arbitration decision time.

Expectancy

Expectancy refers to self-confidence or self-efficacy that is the degree to which we believe we can successfully complete a task. Numerous reviews confirm that the positive relationship between self-efficacy and performance holds true across a wide variety of settings and occupations (e.g., Bandura, 1997; Stajkovic and Luthans, 1998). Self-efficacy increases performance by influencing goal choice, how long people persevere in the face of difficulties and setback, and the intensity of goal pursuit. It also moderates the relationship between goal planning and goal behavior (Lippke et al., 2009). Consequently, those with lower self-efficacy are less likely to choose to work, will work at a more lackadaisical pace, and are more likely to give up once they encounter a scheduling conflict or other obstacles. Accordingly, Steel (2007) meta-analysis found a negative correlation of −0.46 based on 39 studies between self-efficacy and procrastination. We expect that arbitrators who doubt their abilities are more likely to delay.

> *Hypothesis 2.1*: Arbitration decision time should be negatively associated with trait self-efficacy.

Value

Showing a similar strength and direction as expectancy or self-efficacy, value decreases the likelihood of procrastination. Value refers to the reward or pleasure we get from completing or conducting a task. As Steel (2007) meta-analysis confirms, we tend to put off tasks that we find aversive. Consequently, arbitrators who dislike writing, a major component of creating a decision, are expected to delay. In addition, the meta-analysis found that one of the top reasons people give for procrastination is "Didn't have enough energy to begin the task," linking it with task aversiveness. The connection between low energy and aversiveness is well established, with positive affect itself defined as "a state of high energy, full concentration, and pleasurable engagement" (Watson et al., 1988; p. 1063).

Furthermore, there is also a reliable relationship between low affect or energy and reduced self-regulatory skills. Wagner et al. (2012), drawing on the ego depletion model of self-regulation, found that those who lacked sleep are more likely to "cyber loaf." Similarly, in a series of studies, Tice et al. (2007) found that increasing or restoring positive mood result in increased self-regulatory strength. Directly investigating this, Gröpel and Steel (2008) report that energy is linked with enthusiasm and pleasurable engagement, finding that chronic *lack of energy*, that is at a trait level, is one of the best predictors of procrastination. Along these lines, repeatedly research has connected bedtime procrastination to reduced energy and decreased self-regulation, which itself results in more bedtime procrastination (e.g., Exelmans and Van den Bulck, 2021). Accordingly, arbitrators lower in trait energy should take longer to issue awards.

Finally, need for achievement represents an individual's desire for significant accomplishment, mastering of skills, or high standards. A reliable predictor of performance (Judge and Ilies, 2002), those with a higher need for achievement tend to reap more pleasure from accomplishment and often strive for the recognition of their achievements. Steel (2007) meta-analysis, based on 17 studies, places the disattenuated correlation between need for achievement and procrastination at −0.55, making it one of the stronger predictors. For arbitrators, the release of a decision may be a proxy for such recognition or perhaps timely decision releases may be deemed critical for a "successful" arbitrator.

> *Hypothesis 3.1*: Arbitration decision time should be positively associated with task aversiveness.
>
> *Hypothesis 3.2*: Arbitration decision time should be positively associated with lack of energy.
>
> *Hypothesis 3.3*: Arbitration decision time should be negatively associated with need for achievement.

Sensitivity to Time

As Steel (2007) notes, several variables are associated with sensitivity to delay or sensitivity to time, including "distractibility, impulsiveness, and self-control" (p. 73), with Sharma et al. (2014) meta-analytic principal-components factor analysis indicate they all come under a Disinhibition versus Constraint/Conscientiousness factor. Collectively, they are among the strongest predictors of procrastination, meta-analytically demonstrating an absolute disattentuated correlation of 0.62 and account for 100% of the genotypic variance (Gustavson et al., 2014). They enable procrastination by hindering people's ability to delay gratification and to work on what is presently difficult and aversive. Alternatively, taking a behavioral economics approach, Ross et al. (2010) describe them as enabling "hot preference for viscerally attractive awards that operate on agents with disproportionate strength at short ranges" (p. 2). When you are susceptible to temptation, you focus attention upon desires of the moment, neglecting or ignoring long-term responsibilities (e.g., Kuhl, 2000).

> *Hypothesis 4.1*: Arbitration decision time should be positively associated with distractibility.
>
> *Hypothesis 4.2*: Arbitration decision time should be positively associated with susceptibility to temptation.

Perfectionism

Perfectionism has proved a controversial topic for procrastination, with early clinical efforts indicating that this is a major cause but later correlational research suggesting the relationship is weak, negligible or illusionary (i.e., due to an associated third variable). Part of the debate depends on the subdimension focused upon, especially since perfectionism can include the "Organization" construct, which has large and consistently negative correlations with procrastination (Steel, 2007). Including it can mask other positive relations. Two meta-analyses have focused on perfectionism and procrastination (Sirois et al., 2017; Xie et al., 2018), both drawing on Stoeber and Otto (2006) distinction between perfectionist concerns and perfectionist strivings. Perfectionist concerns involve focusing on being evaluated, including perceived discrepancies between performance and standards. Perfection strivings is having high personal standards or expectations. Consistently, perfectionist concerns are considered maladaptive (especially concern with other's evaluation of oneself) while perfectionist strivings were more adaptive (especially striving for high personal standards). As per Sirois et al.'s meta-analysis, the former generated a positive correlation of 0.231 and the latter a negative correlation of −0.218, with similar results by Xie et al. (2018).

However, Sirois et al. (2017) noted that "the differential associations of procrastination to multidimensional perfectionism may also be due to underlying levels of self-efficacy and impulsivity" (p. 154). Xie et al. (2018) partially investigate this, finding that self-efficacy fully mediates the relationship between perfectionism and procrastination, concluding that "TMT can account for the link between perfectionism and procrastination" (p. 404). We replicate and extend the analyses, assessing whether our other predictors also mediate the relationship between procrastination and other-oriented perfectionist concerns, particularly discrepancies.

> *Hypothesis 5.1*: Perfectionism discrepancy should be weakly associated with procrastination.
>
> *Hypothesis 5.2*: Perfectionism discrepancy association with procrastination should be mediated by multiple individual difference variables, especially those related to self-efficacy and sensitivity to time.

Self-Regulatory Skills Influencing Delay

Hoyle (2010) reviews several frameworks that integrate self-regulation strategies with personality traits. One way is to consider self-regulation as the proximal outcome of distal personality processes. From this perspective, there is a loose relationship between the two, providing room for the independent acquisition of self-regulatory strategies and for them to account for unique variance. For example, though organizational skills are related to the personality trait of conscientiousness, they can be trained and acquired (Klein and Lee, 2006). With regards to procrastination, Koch and Kleinmann (2002) argue that time management skills should help reduce hyperbolic discounting and impulsiveness. Using TMT (Steel and König, 2006), we explore three strategies that should help, hinder or reflect arbitrator delay beyond what personality can explain: Organization, Multitasking and Pacing Style.

Organization

Procrastinators tend to be disorganized or, as Schouwenburg (2004) puts it, suffering from "lack of work discipline, lack of time management skill, and the inability to work methodically" (p. 8). Indeed, the disattenuated meta-analytic correlation between organization and procrastination is −0.45 (Steel, 2007). Being organized enhances the ability to set proximate goals, which dependably increases motivation (Locke and Latham, 2004). This effect directly follows from shortening the Delay variable in TMT (Steel and König, 2006; Steel and Weinhardt, 2018). For example, Renn et al. (2011) as well as Gröpel and Steel (2008) confirmed the negative relationship that procrastination has with goal setting, organizing and other forms of self-management. As a result, organized arbitrators are anticipated to have less Decision Time than those whose arbitration practice is more chaotic.

> *Hypothesis 6.1*: Organization should be negatively associated with arbitration decision time.
>
> *Hypothesis 6.2*: Organization should be negatively associated with procrastination.
>
> *Hypothesis 6.3*: Organization should partially mediate the relationship between procrastination and arbitration decision time.

Multitasking

Multitasking is a form of polychronicity, where we work on several tasks at once or quickly move among multiple tasks. As a work strategy, it is typically but not entirely negative. Those with higher levels of working memory and fluid intelligence, who are

dealing with simpler and less cognitively taxing tasks, can indeed multitask effectively (König et al., 2005; Sanderson et al., 2013). However, people can *impulsively* choose to multitask despite performance decrements because it is pleasurable; novelty is rewarding and we acquire this as we switch our attention (König and Waller, 2010; König et al., 2010). Consequently, multitasking can be motivated by susceptibility to temptation, where we switch our attention simply because it is immediately rewarding (Schnauber-Stockmann et al., 2018). On balance, we expect that multitasking is associated with higher levels of procrastination and susceptibility to temptation.

Hypothesis 7.1: Multitasking should be positively associated with arbitration decision time.

Hypothesis 7.2: Multitasking should be positively associated with procrastination.

Hypothesis 7.3: Multitasking should be positively associated with susceptibility to temptation.

Hypothesis 7.4: Multitasking should partially mediate the relationship between susceptibility to temptation and procrastination.

Pacing Style

As reviewed by Steel et al. (2018), pacing refers to how work processes are spread out over time. For procrastinators, it is almost definitional that they take a deadline approach, completing the bulk of their work at the end, with strong empirical support for this style as well. However, delaying behavior alone may not be procrastination and some may delay due to rational reasons, perhaps adeptly making use of the increased focus that occurs before the deadline. For example, Gevers et al. (2015) argue that though procrastination and pacing style overlap, the two are sufficiently different that there should be incremental variance by the latter. To further validate using delay alone as a proxy of procrastination, we examine the relationship between a deadline pacing style and procrastination.

Hypothesis 8.1: A deadline pacing style should be almost synonymous with procrastination.

Task Environment Influencing Delay

Though all procrastination requires delay, not all delay is procrastination. People may put off finishing a task due to other more pressing obligations or a task may be more onerous and take longer. Previous arbitration studies on task delay have exclusively focused on the work or task environment (e.g., Rose, 1986; Barnacle, 1991; Ponak et al., 1996), overlooking or discounting the impact of dispositional variables and self-regulatory techniques. Still, both the type and the process of grievance did influence time delay, accounting for up to 27% of the variance (Thornicroft, 1995). Drawing on these past examinations, we re-examine several key task or environmental factors. In particular, we are interested in comparing the power of these traditional external predictors of delay with individual difference variables.

Workload

It is often suggested that arbitrators, as a group, are "heavily over-committed" (Seitz, 1981), and as a result, arbitrators with a heavier workload will be slower to release decisions. However, Claessens et al. (2010) did not find that workload was related to work completion for a group of R&D engineers. Furthermore, as per Ponak et al. (1996) arbitration study, they found the opposite was true; arbitrators with heavy workloads tend to delay less, perhaps reflecting the Benjamin Franklin's adage "If you want something done, ask a busy person." Workload can be operationalized in terms of the observed number of publicly available written arbitration decisions the arbitrator released in the given year[2]. We disagree with this line of research using observed workload.

The appropriateness of using actual observed workload in this context is debatable. As Berry (1990) wrote, "Time diaries may be the most accurate way to measure how people actually spend their time, but it is the perception that shapes behavior. People who believe they are pressed for time will respond according" (p. 32). Accordingly, workload is often studied using retrospective accounts of time use under the term *busyness*. As defined by Gershuny (2005), "Busyness plainly relates to externally observable work or leisure activities, but the state itself is entirely subjective" (p. 287). Consequently, it can be captured in an arbitration setting through self-reported professional commitments (e.g., mentoring or training other arbitrators, participating in conferences, sitting on professional boards or committees) and personal commitments (e.g., child-rearing responsibilities, illness, divorce, or eldercare issues). Previous research has primarily focused on research and academic writing, finding a positive relationship between delay and perceived busyness (e.g., Boice, 1989; Thompson et al., 2008), but Jiraporn et al. (2009) also found this negative relationship between busyness and performance for corporate directors as well. This is consistent with Hockey (2011) resource allocation model that indicates there is a limit to which increased workload can be offset through increased effort.

Consequently, we expect that self-reported workload, which captures more of life's commitments and potential work-family conflict, should lead to more delays but not necessarily irrational delays that is procrastination. Procrastination is delaying without good reason, with competing responsibilities potentially providing legitimate alternatives.

Hypothesis 9.1: Self-reported workload should be positively associated with arbitration decision time.

Expedited Grievances

Some expedited processes are established by mutual agreement of the parties (e.g., Canadian Railway Office of Arbitration, Canada Post), or imposed by statute (e.g., Ontario, British Columbia). Although individual schemes vary, expedited procedures often include speeding the process such as by skipping steps or reducing the time allowed to select arbitrators, schedule hearings,

[2]In Canada, from which one sample of our arbitrators are drawn, the law requires that all arbitration decisions be publicly reported and are available electronically.

and issue awards. Consequently, expedited arbitration provides processes designed to shorten the time to decision.

> *Hypothesis 10.1*: Expedited grievances should be negatively associated arbitration decision time.

Grievance Complexity

Generally, only the most thorny and significant grievances cannot be resolved internally and proceed to arbitration (Trudeau, 2002). There has been a marked growth in the complexity of the law that must be considered in many decisions. For example, while anti-discrimination rules or certain legislated employment standards may not be expressly set out in the collective agreement, the arbitrator is obliged to respect their provisions and interpret the collective agreement to conform to employment related statutes (Weber v Ontario Hydro, 1995; *Parry Sound*). Sensibly, studies have found that Decision Time in a simple case is less than a complicated one (Ponak et al., 1996). Complexity is usually operationalized by page length of the decision (i.e., complex grievance require more pages to be addressed) and time span of hearing days (i.e., due to the complexity of the grievance, parties will often require scheduling of additional hearing days).

In addition to complex grievances taking longer, we also expect an interaction between grievance complexity and procrastination. When examining deadline driven goal striving, Schmidt et al. (2009) found *interactions* between the individual difference variable of goal orientation and the environment. Under certain conditions, those with a strong avoidance orientation tend to focus on more readily attainable tasks. Similarly, procrastination tends to increase under a variety of conditions, especially when the task becomes more difficult, when it becomes less enjoyable or when the time to completion increases (Steel, 2007). In the words of Lay and Brokenshire (1997), "procrastinators are more susceptible to variation in task aversiveness, compared to non-procrastinators" (p. 85), with susceptibility necessarily indicating an interaction. Complex tasks potentially have all three elements: difficult, less enjoyable and lengthy. Though everyone should take longer finishing complex grievances, procrastinators should take even longer than usual.

> *Hypothesis 11.1*: Grievance complexity should be positively associated with arbitration decision time.

> *Hypothesis 11.2*: The interaction between grievance complexity and procrastination should be positively associated with arbitration decision time.

MATERIALS AND METHODS

With a few notable differences, our method of investigation is similar to Claessens et al. (2010) examination of procrastination, who analyzed 878 self-reported tasks recorded by 29 R&D engineers. For example, whereas Claessen et al. exclusively used self-report data, we also rely on observed behavior. Using a multilevel approach, our individual difference, self-regulatory and self-report workload variables are level two, based on 49 individuals, while the remaining task environment variables and observed workload are level 1, based on 1370 observed case characteristics.

For 49 level 2 participants, a single-tailed power analysis indicates a 67% chance of detecting as significant correlates of 0.30. Of note, the subsequent replication of these level 2 analyses with American arbitrators increases the statistical power to over 99%. Furthermore, as per Scherbaum and Ferreter (2009), these are extremely favorable conditions for multilevel modeling, matching their best-case scenario, which was 40 level 2 participants with an average sample size of 30 for level 1 (i.e., 1200 cases). Scherbaum and Ferreter estimate statistical power for this condition based on a medium effect is 95%.

To assist in following the expected relationships, we summarize the variables graphically in **Figure 1**, with the dotted line indicated the expected interaction between procrastination and grievance complexity. We discuss the methodology to examine each of these relationships in turn.

Participants (Level 2)

Our target population of Canadian arbitrators who are members of the NAA is relatively small, approximately 60–70 people depending on the exact year. From this group, 49 agreed to participate, a response rate of approximately 75%. This response rate is largely due, as mentioned, to two of the authors being active within the NAA. Also, these respondents represent a high proportion of the entire labor arbitration "business" as it is highly concentrated. Between 31 and 35% of all Canadian cases are decided by NAA members (Trudeau, 2002). Average age was

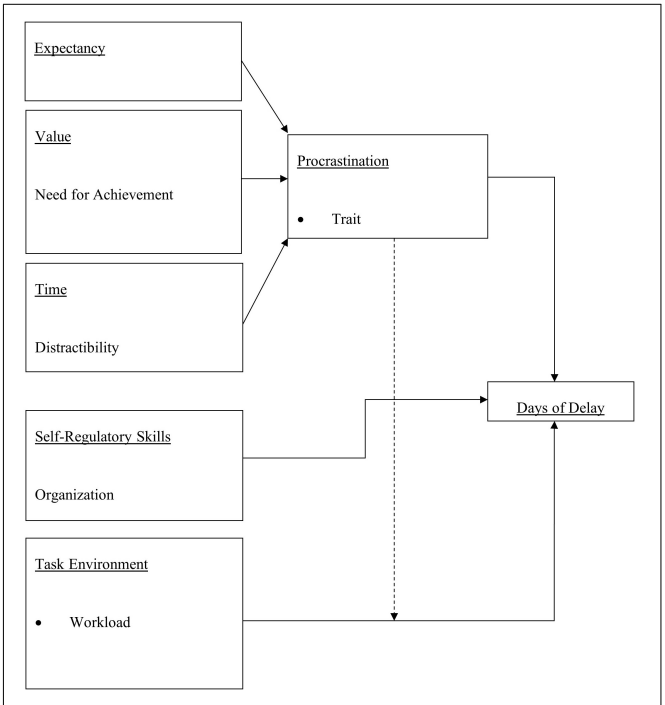

FIGURE 1 | Relationship among individual difference motivational variables, self-regulatory skills, task environment and observed days of delay.

approximately 46–50, 75% were men, and 80% were married. The average years of arbitration practice was 16–20, though most were NAA members for only 6 to 10 years.

Participants responded to over 200 questions, either through an online survey or identical hardcopy paper versions handed out during the NAA Annual Meeting. This approach was necessary to ensure coverage across all participants, though the majority of arbitrators responded through the online version. There were no cases in which a participant responded to both versions of the survey. Means, standard deviations and reliabilities of the measures are all reported in **Table 1**. To provide ensure domain coverage, the individual difference variables were typically operationalized in several ways, all at the trait level. Procrastination was assessed through two scales, the nine item Irrational Procrastination Scale (Steel, 2010; e.g., "I delay tasks beyond what is reasonable") and a three-item content valid procrastination scale specific for arbitration (e.g., "The quality of my arbitration decisions is impaired by my procrastination"). The measurement of expectancy was through the Work Self-Efficacy Scale (Speier and Frese, 1997; e.g., "If I am in trouble, I can think of a solution"). The measurement of value was assessed at the trait level by three scales. Energy was measured by the Lack of Energy Scale (Kuhl and Fuhrmann, 1998; e.g., "If work is distasteful or boring, I have to force myself to get going"), need for achievement was measured by the Personality Research Form (Jackson, 1984; e.g., "I enjoy difficult work"), and task aversiveness for arbitration writing was measured by a content valid three-item scale (e.g., "I enjoy writing arbitration decisions" – reverse scored). Finally, sensitivity to delay was measured by the Attentional Distractibility Scale (Kuhl and Fuhrmann, 1998; e.g., "My mind wanders when I try to concentrate") and the Susceptibility to Temptation Scale (Steel, 2010; "It takes a lot for me to delay gratification").

For the self-regulatory variables, we devised scales relevant for the arbitration practice based on inputs from two authors of the study who are part of the arbitration community. Organization was measured by a three-item scale (e.g., "I am very methodical in the way I approach my arbitration practice"). Multitasking was assessed with a 12-item scale (e.g., "I multitask," "I write in short bursts between other non-writing activities").

For busyness, we had the arbitrators retrospectively estimate work and personal commitments across separate life domains for that period. On a five-point scale, ranging from "Not at all" to "Extremely," they indicated how involved they were in the following areas: Arbitrator selection, processes and evaluations; Mentoring other arbitrators; Conference preparation; Non-arbitration work; Physical fitness and recreation; Caring for children or grandchildren; Elder care for relatives; and Charity/community events/volunteer work. These life domains were selected based on a pilot study where five NAA practitioners were interviewed about activities that could impact the speed at which they write decisions. A self-report Workload item was devised by summing responses across all life domains.

Task Environment (Level 1)

By law, almost all arbitrators in Canada must file their decisions with a Ministry of Labour or an equivalent body and these decisions are publicly available. We acquired all cases produced by our arbitrator sample over a 3-year period (2003–2005, inclusive). Three years' worth of cases enabled us to develop an accurate portrait of the "normal" workflow of any arbitrator. The comprehensive data set of cases is a significant advantage of doing research in the Canadian setting. By contrast, American arbitration decisions are not routinely filed and are considered to be private documents[3].

From the original group of 49 participating arbitrators, 41 were practicing during our sample period or provided hearing dates with which to measure arbitration delay. In total, LexisNexis® *Quicklaw*™ Research Service provided full-text retrieval of all 1,370 cases, for an average of 33.4 cases per arbitrator. This number reduced to 1,204 cases from 40 arbitrators after eliminating panel decisions. Notably, this figure compares favorably with the 350 cases analyzed by Thornicroft (1995), the 600 cases by Ponak et al. (1996) or the 800 cases by Barnacle (1991).

Our coding adopted the approach of Ponak et al. (1996). The dependent variable, Decision Time, is the elapsed time between the date of the final hearing and the issuance of the award. Decision Time is an unobtrusive and concrete measure, as arbitrators routinely include this information without any notion that researchers will make use of it. We found that the average Decision Time was 61 days, comparable to the average of 93 days reported in the United States (Federal Mediation and Conciliation Service, 2011). However, with a range from same day to 1639 days per case or an average delay of 13 to 718 days per arbitrator, the positive skew was substantial. Accordingly, for comparisons with level 2 variables, we used a logarithmic transformation, reducing skew from 5.92 to 1.48 but still correlating with the untransformed scale at 0.79.

In addition, we distinguished regular and expedited cases and coded for grievance complexity. Complexity was assessed in terms of page length and time span of hearing. However, after standardizing these two variables, they formed a scale with a Cronbach's Alpha of just 0.52, suggesting separate analyses for each. Finally, workload was operationalized as the publicly available written arbitration decisions the arbitrator released in the given year.

RESULTS

Means, standard deviations and reliability among the self-reported procrastination and self-regulatory variables, where applicable, are reported in **Table 1**. Compared with other adult (40 + years) employes, arbitrators are over a full standard deviation higher in Self-Efficacy (Speier and Frese, 1997) and Need for Achievement (Jackson, 1984) but lower in Trait Procrastination (Steel, 2010). Range restriction was not a concern, with standard deviations being no lower than

[3]Publicly reported labor arbitration decisions in the United States are not representative of the universe of labor arbitration decisions (Steiber et al., 1985). In contrast, since all labor arbitration decisions in Canada must be reported by law, our data set contains the universe of decisions of the arbitrators in our sample.

TABLE 1 | Descriptive statistics and Pearson correlations among personality and self-regulatory variables for Canadian arbitrators.

	Mean	Std.	1	2	3	4	5	6	7	8	9	10
Procrastination												
1 Trait Procrastination	2.33	0.63	*0.82*									
2 Arbitration Procrast.	2.28	0.78	0.52**	*0.73*								
Expectancy Variables												
3 Self-Efficacy	4.08	0.47	−0.34*	−0.38**	*0.85*							
Value Variables												
4 Task Aversiveness	2.18	0.82	0.33*	0.14	−0.04	*0.71*						
5 Lack of Energy	2.09	0.62	0.58**	0.31*	−0.11	0.34*	*0.82*					
6 Need for Achievement	3.58	0.54	−0.30*	−0.38	0.60**	−0.07	−0.31*	*0.84*				
Temporal Variables												
7 Distractibility	1.98	0.57	0.31*	0.20	−0.27	0.20	0.62**	−0.43**	*0.80*			
8 Susceptibility to Tempt.	2.17	0.61	0.69**	0.43**	−0.20	0.43**	0.65**	−0.38**	0.37**	*0.83*		
Self-Regulatory Skills												
9 Organization	4.03	0.62	−0.61*	−0.31*	0.44**	−0.22	−0.29*	0.34*	−0.16	−0.11	*0.51*	
10 Multitasking	2.86	0.64	0.36*	0.28	0.08	0.15	0.33*	0.07	0.10	0.44**	−0.01	*0.77*

*N = 49. Cronbach Alpha italicized along the diagonal. *$p < 0.05$, **$p < 0.01$.*

75% of population estimates. We used Harman's Single-Factor Test to evaluate the extent of common method variance after grouping items into three packets. The items were divided into packets because using all of them simultaneously resulted in a non-positive definite matrix. The single factor accounted for substantially less than 50% of the variance, which is the threshold used to indicate common method concerns, with estimates of 13, 28, and 26% of the variance across item subsets. All scales show good reliability with the exception of Organization, which has an alpha of 0.51 but it is retained in the analyses as it still achieves a correlation of −0.61 with procrastination.

We investigated the relationship that Decision Time has with the level 2 variables using Weighted Least Squares (WLS) regression. The number of cases upon which to estimate Decision Time varied from 1 to 101 and consequently we give more weight to arbitrators with more cases as they will provide a better estimate of delay. The correlation between number of cases and procrastination itself was non-significant ($r = -0.18$, $p = 0.26$). WLS regression results are reported in **Table 2**. Procrastination had a strong relationship with observed delay, accounting for 23% of the variance in this measure. Arbitration Procrastination, despite being specific to the situation, predicted slightly less variance, 17%. Trait Procrastination predicts arbitrator delay, supporting Hypothesis 1.1.

We then investigated procrastination's relationship with Expectancy, Value and Sensitivity to Time related trait variables. As shown in **Table 1**, all the variables correlate as expected with Trait Procrastination. Arbitration Procrastination shows a similar relationship, though Task Aversiveness and Distractibility slip below statistical significance. **Table 3** provides a hierarchical regression of dispositional and self-regulatory variables predicting Trait Procrastination. Every step incrementally predicts, and 57% (50% adjusted R^2) of the variance is accounted for with the dispositional variables alone, supporting Hypothesis 1.2. To investigate Hypothesis 1.3 (whether Trait Procrastination mediates the relationship between Expectancy, Value and Sensitivity to Time and Decision Time), we conducted a series of Sobel tests for mediation. Taking the strongest relationship between Decision Time at each hierarchical step, as per **Table 2**, we tested the mediation effects of Procrastination for Self-Efficacy, Lack of Energy and Susceptibility to Temptation using Preacher and Leonardelli (2015) interactive calculation tool. While regression weights and standard errors for Path A were obtained via linear regression, for Path B these were generated via WLS regression (as per **Table 2**), a methodology that does not

TABLE 2 | WLS bivariate regression of arbitrator decision time (log transformed) with personality and self-regulatory variables.

	R	R^2	*B*	*p*
Procrastination				
Trait Procrastination	0.40	0.16	0.41	0.011
Arbitration Procrastination	0.38	0.15	0.35	0.015
Expectancy Variables				
Self-Efficacy	0.04	0.00	−0.05	0.800
Value Variables				
Task Aversiveness	0.48	0.23	0.37	0.002
Lack of Energy	0.32	0.10	0.38	0.046
Need for Achievement	0.32	0.10	−0.36	0.046
Temporal Variables				
Distractibility	0.35	0.12	0.40	0.026
Susceptibility to Temptation	0.40	0.16	0.46	0.012
Self-Regulatory Skills				
Organization	0.36	0.13	−0.33	0.023
Multitasking	0.48	0.23	0.45	0.002
Workload				
Observed Workload	0.03	0.00	0.00	0.842
Self-Report Workload	0.42	0.17	0.50	0.008

N = 40.

TABLE 3 | Hierarchical regression analysis predicting procrastination with dispositional and self-regulatory variables.

Step and predictor variable	*B*	*SEB*	R^2	Δ R^2	*p*
1 Expectancy			0.11	0.11	0.021
Self-Efficacy	−0.45	0.19			
2 Value			0.43	0.32	<0.001
Self-Efficacy	−0.41	0.20			
Task Aversiveness	0.12	0.09			
Lack of Energy	0.52	0.13			
Need for Ach.	0.06	0.18			
3 Sensitivity to Time			0.57	0.14	0.003
Self-Efficacy	−0.41	0.18			
Task Aversiveness	0.02	0.09			
Lack of Energy	0.30	0.17			
Need for Ach.	0.16	0.17			
Distractibility	−0.10	0.15			
Susceptibility to Temptation	0.53	0.15			
4 Self-Regulatory Skills			0.73	0.16	<0.001
Self-Efficacy	−0.15	0.16			
Task Aversiveness	−0.04	0.07			
Lack of Energy	0.11	0.14			
Need for Ach.	0.19	0.14			
Distractibility	0.02	0.13			
Susceptibility to Temptation	0.54	0.14			
Organization	−0.48	0.10			
Multitasking	0.09	0.10			

N = 48. Bolded variables are entered during that step.

accommodate alternative bootstrapping techniques sometimes employed for mediation based on smaller sample sizes. Still, in all cases there was significant and similar levels of mediation for Procrastination, with the Sobel test identical to the first decimal point ($p = 0.04$) across all three analyses.

We then tested the relationship Decision Time has with the Expectancy, Value and Sensitivity to Time related trait variables, that is Hypotheses 2.1 through 4.2. As expected, being more distal to Decision Time than procrastination (procrastination being just one factor that can increase delay), these relationships have on average roughly half the effect size, with an average *R* of 0.28 compared to procrastination's 0.45 (**Table 2**). Regarding Expectancy (Hypothesis 2.1), received no support ($p = 0.90$). On the other hand, Hypotheses 3.1 and 3.2 regarding Value were supported. Task Aversiveness ($p = 0.02$) and Lack of Energy ($p = 0.02$) were significant. Also, Need for Achievement (Hypothesis 3.3) was trending in the expected direction ($B = -0.32$) and statistically significant for a one-tailed test ($p = 0.09$). Similarly, Sensitivity to Time's Hypothesis 4.2 for Susceptibility to Temptation was significant ($p = 0.01$) and Distractibility (Hypothesis 4.1) trending in the expected direction ($B = 0.30$) as well as borderline statistically significant at one-tailed ($p = 0.10$). Hypotheses 5.1 and 5.2 are addressed in the subsequent dataset.

Concerning self-regulatory skills, **Table 1** considers their relationship with Procrastination and **Table 2** with Decision Time. Organization and Multitasking are strongly related to both Procrastination and Decision Time, supporting Hypotheses 6.1, 6.2, 7.1, and 7.2. Similarly supportive, as set out in **Table 3, Organization** and **Multitasking** incrementally predict Trait Procrastination, adding 16% additional variance for a total of 73% (67% adjusted R^2), with most of the variance provided by Organization. As per **Table 1**, Organization is negatively associated with Trait and Arbitrator Procrastination. Regarding Multitasking, it is associated with Trait Procrastination, though drops below significance for Arbitrator Procrastination. Using Preacher and Leonardelli (2015) interactive calculation tool as previously reviewed, Hypothesis 6.3 was confirmed: the Sobel test was significant ($p = 0.03$), and Organization mediates the relationship between Procrastination and Decision Time. Also, as per Hypothesis 7.3, Procrastination is associated with Susceptibility to Temptation, indicating as expected that the work strategy is typically detrimental and likely environmentally cued rather than autonomously pursued. Consistent with Hypothesis 7.4, Multitasking mediated the relationship between Susceptibility to Temptation and Procrastination ($p = 0.04$).

Bivariate correlations of Workload, both observed ($r = 0.17$, $p = 0.30$) and self-reported ($r = -0.12$, $p = 0.40$), with procrastination were not significant. **Table 2** indicates that while Observed Workload was not related to Decision Time, there was a strong positive relationship between Self-Report Workload and Decision Time, supporting Hypothesis 9.1. **Table 4** investigates this relationship further. Though all life domains have comparable mean levels of involvement, two accounted for most of the variance in Decision Time: (1) Arbitrator selection, processes and evaluations, and (2) Non-arbitration work. Consequently, this appears to be a form of role strain, such as role overload or intra-role conflict (Pearlin, 1989; Tubre and Collins, 2000). In other words, when there are several work tasks to pursue of similar importance or subject matter, interference among these tasks has the potential to increase, where one takes the place of another.

Multilevel Modeling

Because our data have a multilevel structure (cases nested within individuals), all analyses involving case or task characteristics were conducted using multilevel modeling using the *R* (version 4.1.1) package "nlme" (version 3.1–153). Like other widely used programs, nlme uses random-coefficient modeling for multilevel data and performs appropriate adjustments to the analytical procedures to account for nested data. Our complexity variables of Decision Length and Time Span of Hearing as well as Procrastination were centered prior to forming their cross-level interaction. Total observations were 1204 cases (level 1) from 40 arbitrators (level 2).

Descriptive statistics and a correlation matrix of our data are presented in **Table 5**. **Table 6** presents the results of our multilevel analysis predicting days of delay. Initially, we tested a random intercept null model, where each arbitrator gets their own intercept, using it to calculate the Intraclass Correlation Coefficient (ICC). Approximately 66% of the variance is at level 2 or the arbitrator level, justifying taking a multilevel approach and supporting that individual-differences are a major contribution to delay.

TABLE 4 | Mean self-report workloads and WLS regression analysis predicting arbitrator delay with self-report workloads.

Predictor variable	*Mean*	*B*	*SEB*	*p*
Arbitrator selection, processes and evaluations	1.51	0.256	0.106	0.022
Mentoring other arbitrators	2.18	−0.273	0.154	0.087
Conference preparation	2.27	0.021	0.122	0.865
Non-arbitration work	2.07	0.175	0.087	0.055
Physical fitness and recreation	3.40	0.098	0.120	0.420
Caring for children or grandchildren	2.72	−0.001	0.071	0.989
Elder care for relatives	1.70	0.109	0.080	0.184
Charity/community events/volunteer work	2.07	0.017	0.083	0.844
Other hobbies	2.44	0.046	0.086	0.601

N = 39. R^2 = 0.47, Adj. R^2 = 0.30, p = 0.017.

TABLE 5 | Descriptive statistics and Pearson correlations among variables for multilevel analysis.

	Mean	SD	1	2	3	4	5
Level-One Variables							
1 Days of delay	43.54	77.89	–				
2 Observed Workload	21.66	43.32	−0.01	–			
3 Expedited	0.09	0.28	−0.09**	−0.01	–		
4 Decision Length	10.68	9.53	0.24**	−0.06*	−0.10**	–	
5 Time Span	46.90	129.11	0.37**	−0.01	−0.07**	0.35**	–
Level-Two Variable							
6 Procrastination	0.00	1.00	0.13**	0.11**	−0.01	−0.09**	0.00

*Level-1 observations, N = 1204; Level-2 observations, N = 40. *p < 0.05, **p < 0.01.*

The results reconfirm our previous analysis; Observed Workload is not related to delay. They also re-confirm that Trait Procrastination is significantly associated with the number of days it takes to render a decision (i.e., Hypothesis 1.1). The coefficient indicates that for each standard deviation increase in procrastination, elapsed time from hearing to decision increased by 28.29 days (t = 2.06, p = 0.046). Having a similar effect but in the opposite direction is Expedited cases, as per Hypothesis 10.1. Expediting a case *reduces* Decision Time by an average of 20.54 days (t = −2.99, p < 0.01). In other words, it would be preferable to select a low procrastination arbitrator without expediting than a high one with. Using the means from **Table 5** with the coefficients from **Table 6** (with the exception of Time Span, which being standardized has a mean of zero), we can calculate the impact of procrastination on delay. Keeping all other variables constant at their average, arbitrators one standard deviation above on procrastination take 82.94 days while those one standard deviation below take 26.38 days.

Finally, grievance complexity as measured by Decision Length increased Decision Time, with each written page adding 1.19 days (t = 5.25, p < 0.001). Similarly, our other complexity measure, the Time Span of Hearing Days, also significantly contributed to delay (t = 11.25, p < 0.001), which is somewhat harder to interpret as it follows a Pareto distribution with approximately half the cases (643 or 53.4%) at the lowest value or 1. Still, as the time span increases, so does decision time, supporting Hypothesis 11.1. For both these complexity measures, we detected an almost identical interaction with procrastination: for Decision Length (coefficient = 6.948, t = 3.67, p < 0.001) and for Time Span of Hearing Days (coefficient = 11.41, t = 4.19, p < 0.001). Given their redundancy, we incorporate just the interaction effect for Time Span of Hearing Days in **Table 6** (though both analysis scripts are available in our OSF folder). To illustrate the interaction, we use reghelper's (version 1.0.2) "nlme" option to run a Simple Slopes analysis in *R*. The simple slope for time span of hearing was positive and strong (coefficient = 34.07, t = 10.41, p < 0.001) for those who were one standard deviation above the mean in procrastination, but the simple slope for time span of hearing was a third the size (coefficient = 11.25, t = 3.22,

TABLE 6 | Multilevel modeling results predicting decision time (days of delay).

	Value	Std. Error	*t*-score	*p*-value
Level-One Coefficients				
Constant	44.77	14.92	3.00	0.0028
Observed Workload	−0.07	0.13	−0.54	0.5900
Expedited	−20.54	6.87	−3.99	0.0000
Decision Length	1.19	0.23	5.25	0.0028
Time Span (standardized)	22.66	2.01	11.25	0.0000
Level-Two Coefficient				
Procrastination (standardized)	28.29	13.73	2.06	0.0463
Cross-Level Interaction				
Time Span × Procrastination	11.41	2.72	4.19	0.0000

Level-1 observations, N = 1204; Level-2 observations, N = 40.

p = 0.001) for those who were one standard deviation below the mean in procrastination, supporting Hypothesis 11.2. In other words, those low in procrastination pursued tasks at nearly the same pace regardless of the underlying complexity. Those high in procrastination increasingly dillydallied the more complicated tasks became.

STUDY TWO: AMERICAN ARBITRATORS

Following up on the Canadian Arbitrators from Study One, we replicated as well as extended our study with a larger group of American Arbitrators. As mentioned, the task related variables were unavailable for this group as was the associated surreptitious measure of observed delay (i.e., unlike for Canada, this information is not part of the public record). However, we were able to assess the majority of the key self-report variables, including: procrastination, self-efficacy, task aversiveness, lack of energy, distractibility, work load/busyness, and multitasking. To address Hypotheses 5 and 8, we made space for two relevant variables, Pacing Style and Perfectionism, by swapping out the items related to Organization and Need for Achievement (i.e., the reliability of the former was marginal, and the latter was borderline significant).

MATERIALS AND METHODS

Participants

Of the approximately 600 United States members of the NAA, we obtained responses from 195, or 35% of the total population. Average age reported was 70 to 79 by 51% of the respondents, 72.3% were men and 27.7% were women, 84.6% were married with 2% reporting never married, 95.4% reported having an advanced graduate and/or law degree, and 71.8% hearing arbitration cases for 26 years or more. This represents a well-established and experienced group of arbitrators.

Measures

Measures employed were largely a subset of Study One's, specifically those scales dealing with: procrastination, self-efficacy, task aversiveness, lack of energy, distractibility, and multitasking. Reference Study One for details. We also made one refinement and two additions. Consistent with Study One, we assessed self-report workload or busyness but this time used a more standardized scale, the Martin and Park Environmental Demands (MPED) Questionnaire (Martin and Park, 2003). Its six-item scale asks questions such as "I am very busy during an average day." We also assessed Pacing Style using the nine-item Pacing Action Categories of Effort Distribution (PACED). It consists of three scales: *Deadlines* (completing work just before the due date; e.g., "I generally do not work until there is time pressure from an approaching deadline"), *U-Shaped* (completing work mostly at the start and finish with a break in between; e.g., "The effort I put into projects is high at the start, low half-way through, and high again at the end"), and *Steady* (complete work at an even pace throughout; e.g., "I work in a slow, but steady, manner to complete tasks"). Finally, to measure perfectionism's discrepancy dimension, we used three items from the Revised Almost Perfect Scale (Slaney et al., 2001), framed to assess other-focused rather than self-focused discrepancy, specifically: "Others are hardly ever satisfied with my performance," "My best just never seems to be good enough for others," and "My performance rarely measures up to other people's standards." As per Study One, we used Harman's Single-Factor Test to evaluate common method variance, and found that the single factors accounted for 29, 14, and 17% of variance across item subsets.

RESULTS

Correlations and univariate statistics are reported in **Table 7**. Contrasting **Table 2**, for Canadian Arbitrators, with **Table 7**, for American Arbitrators, both appear to be largely identical. Means and standard deviation were largely duplicated, with mean trait levels of procrastination remaining low across both groups (i.e., 2.33 versus 2.17). Correlations also replicated, with the exception of Distractibility, which showed *increased* correlations in Study Two. For example, its correlation with Procrastination increased from 0.31 to 0.61. In all, the original correlation matrix for Study One appears robust and generalizable. Consequently, the associated hypotheses from Study One also found support here. Multitasking correlates with Procrastination and Susceptibility to Temptation (Hypotheses 7.2 and 7.3) as well as mediates between them at $p < 0.01$ (Hypothesis 7.4).

Nominally, the correlation between procrastination and deadline pacing style is 0.70. However, after disattentuating due to reliability, the corrected correlation increases to 0.94, indicating that they are interchangeable, supporting Hypothesis 8.1. The correlation with the u-shaped pacing style was much lower, at 0.36 or 0.43 corrected. The steady pacing style was −0.70 or −0.87 corrected. Though there can be times when people delay rationally, as in the u-shaped pacing style, as people reserve their work *exclusively* to the end, it strongly reflects procrastination. Also of interest is that busyness (self-report workload) and multitasking correlate positively with procrastination and with each other (r = 0.59). Notably, Malkoc and Tonietto (2019) would classify all these three variables as part of an activity maximization strategy, where to cope with our busyness we rely on deadlines and multitasking. In contrast, an outcome maximization strategy employs instead a steady pacing style.

Partially duplicating **Table 3**, the multiple regression prediction of procrastination with Canadian arbitrators, we have **Table 8** for American arbitrators. Again, the results are largely the same, with a R^2 of 0.57 after step 3 for Canadian arbitrators and a R^2 of 0.56 after step 3 for American arbitrators, with a parallel pattern of beta weights. Hypothesis 1.2 is re-confirmed. **Table 8** diverges in that it does not include the variables Organization or Need for Achievement, but otherwise the pattern of beta weights remains similar.

Finally, we considered perfectionism's connection to procrastination and whether it indeed is mediated. As per **Table 7**, the correlation between the two is 0.17 ($p < 0.05$),

TABLE 7 | Descriptive statistics and Pearson correlations among self-report variables for American arbitrators.

	Mean	Std.	1	2	3	4	5	6	7	8	9	10	11	12
Procrastination														
1 Trait Procrastination	2.17	0.65	*0.86*											
Expectancy Variables														
2 Self-Efficacy	4.02	0.51	−0.24**	*0.77*										
Value Variables														
3 Task Aversiveness	1.98	0.82	0.37**	−0.21**	*0.71*									
4 Lack of Energy	2.18	0.64	0.61**	−0.15*	0.36**	*0.83*								
Temporal Variables														
5 Distractibility	2.09	0.70	0.61**	−0.26**	0.44**	0.58	*0.90*							
6 Susceptibility to Tempt.	2.11	0.58	0.70**	−0.12	0.29**	0.74**	0.70**	*0.84*						
Pacing Style														
7 Deadline	1.97	0.73	0.70**	0.00	0.32**	0.50**	0.35**	0.49**	*0.64*					
8 U Shaped	2.16	0.88	0.36**	−0.06	0.17*	0.43**	0.37**	0.44**	0.34**	*0.80*				
9 Steady	3.83	0.78	−0.70**	0.20**	−0.38**	−0.47**	−0.41**	−0.58**	−0.53**	−0.43**	*0.76*			
Self-Regulatory Skills														
10 Multitasking	2.71	0.54	0.35**	0.07	0.20**	0.24**	0.22**	0.31**	0.32**	0.26**	−0.16*	*0.67*		
Workload														
11 Self-Report Workload	2.41	0.69	0.34**	0.05	0.14	0.26**	0.26**	0.31**	0.24**	0.20**	−0.23**	0.59**	*0.75*	
Perfectionism														
12 Discrepancy	1.48	0.54	0.17*	−0.28**	0.16*	0.29**	0.24**	0.22**	0.00	0.34**	−0.10	0.05	0.02	*0.70*

*N = 185 to 194 (due to pairwise deletion for missing responses). Cronbach Alpha italicized along the diagonal. *p < 0.05, **p < 0.01.*

TABLE 8 | Hierarchical regression analysis predicting procrastination with dispositional and self-regulatory variables for American arbitrators.

Step and predictor variable	*B*	*SEB*	R^2	ΔR^2	*p*
1 Expectancy			0.06	0.06	0.001
Self-Efficacy	−0.32	0.01			
2 Value			0.44	0.38	< 0.001
Self-Efficacy	−0.18	0.08			
Task Aversiveness	0.11	0.05			
Lack of Energy	0.57	0.06			
3 Sensitivity to Time			0.56	0.12	< 0.001
Self-Efficacy	−0.15	0.07			
Task Aversiveness	0.08	0.05			
Lack of Energy	0.17	0.08			
Distractibility	0.17	0.07			
Susceptibility to Temptation	0.45	0.10			
4 Self-Regulatory Skills			0.58	0.02	0.01
Self-Efficacy	−0.16	0.07			
Task Aversiveness	0.06	0.05			
Lack of Energy	0.17	0.08			
Distractibility	0.17	0.07			
Susceptibility to Temptation	0.41	0.10			
Multitasking	0.18	0.07			

N = 176. Bolded variables are entered during that step.

confirming Hypothesis 5.1. If we add perfectionism to **Table 8**'s series of regression analyses predicting procrastination, it increases R^2 by a non-significant 0.001 (p = 0.280). Similar to Study One, we conducted a series of mediation analyses using the 2014 update of Preacher and Hayes (2004) Sobel test, with estimates based on 5,000 bootstrap resamples. The direct effect of perfectionism on procrastination for the following mediator models were: Self-Efficacy (0.137, p = 0.122), Distractibility (0.103, p = 0.664), Susceptibility to Temptation (0.027, p = 0.684), Lack of Energy (0.002, p = 0.973), Task Aversiveness (0.141, p = 0.085), and Multitasking (0.188, p = 0.023). With the exception of multitasking, every other variable's mediation was sufficient to drive perfectionism's direct effect to non-significance. As per Hypothesis 5.2, Sirois et al. (2017) suspicions and Xie et al. (2018) findings are borne out. Perfectionism is not directly related to procrastination.

DISCUSSION

Despite its ubiquity, procrastination has been almost exclusively studied with student samples and academic deadlines. We address this omission by studying observed delay in a critical area, the justice setting, where we are counseled that justice should not only be sure but also *swift*. Many nations embrace "speedy trial" principles, reflected in the Sixth Amendment to the United States Constitution and Section Eleven of the Canadian Charter of Rights and Freedoms. Here, we establish that procrastination appears to be endemic among the workplace, it is a major contributor to delay, it can be largely explained by Temporal Motivation Theory (Steel and König, 2006) and that procrastinators are especially susceptible to task difficulty or aversiveness. Procrastination, though unlikely to be eradicated, appears to be reduceable by addressing self-regulatory skills, such as increasing organizational skills and avoiding multitasking. There was little to no support for perfectionism being a cause of procrastination.

The Prevalence of Procrastination

We studied arbitrators, who are both an ideal and a stringent test of personality and task effects on workplace procrastination. Arbitrators have high degrees of autonomy, meaning that personality effects should not be erased by high situational strength. The nature of their work provides a difficult to obtain criterion: an objective and valid measure of task delay, which is a key indicator of performance for arbitrators. It is stringent because although arbitrators have opportunities to delay, they have strong motivations not to and are carefully selected by both management and union representatives. As Domke and Edmonson (2003) underscore "The arbitrator is a decisive element any arbitration. The success or failure of arbitration will largely depend on them" (p. 24). Furthermore, given that arbitrators in our sample had practiced for a number of decades on average, there was ample time for less competent arbitrators or chronic procrastinators to self-select themselves out of the profession (Schneider, 1987). Indeed, average levels of procrastination, which are over 1.5 standard deviations lower than the average population (Steel, 2010), and other related traits indicate they are a group who should procrastinate remarkably little. And yet we still detected a substantive effect.

Given that procrastination made a substantive impact on the performance of this rarefied group of highly trained and

motivated arbitrators, procrastination should be a significant factor in most autonomous work situations. Epidemiological work by Steel and Ferrari (2013) indicates that procrastination is indeed a global phenomenon with significant levels in most demographic categories. Supporting this conclusion is research showing procrastination substantively occurring in settings ranging from academic publication (Lay, 1987; Ackerman and Gross, 2007) to unemployment search (Lay and Brokenshire, 1997; van Hooft et al., 2005).

The Importance of Procrastination

Since procrastination is putting off despite expecting to be worse off, it is naturally detrimental. Only its negative impact varies, tending to intensify the higher the stakes (Steel, 2011). As mentioned, timeliness is a critical performance dimension in the justice field in general and for arbitrators specifically and, as expected, trait procrastination was a major predictor of Decision Time. Arbitrators one standard deviation above the mean in terms of procrastination took over twice as long as arbitrators one standard deviation below. The effect of procrastination is virtually identical, though opposite in direction, to that of expedited cases, which represent the combined effect of several procedural interventions designed to speed task completion (e.g., allowing arbitrators to issue non-precedent setting awards). Similarly, procrastination's effect on Decision Time was comparable to the effect of workload, which was the combined effect of other personal and work commitments. In short, personality effects on Decision Time were as strong as environmental procedures or external obligations.

Still, it is worth stressing that the procedural interventions were successful in reducing delay (i.e., expedited cases). If organizations find timeliness a problem, it can be partially ameliorated through well-designed processes. As Heath and Anderson (2010) note while reviewing external causes of undue delays, "supportive social scaffolding enables us to keep procrastination in check" (p. 233). For example, elements that speed task completion include the establishment of social norms, environmental cues and reminders, public and specific implementation intentions, and institutionally enforced rewards and repercussions (Steel, 2011). However, given that the practice of job design has generally drawn on mechanistic rather than motivational models, this avenue appears typically unexploited (Campion et al., 2005).

The importance of procrastination should be of more surprise to those who have adopted a rational model of human behavior, often associated with neo-classical economics (Posner, 1998; Ashraf et al., 2005). According to economic theory, which is essentially Expectancy × Value formulations, procrastination should not exist, being an irrational delay, or at least not have a substantive impact. Reflecting the lack of field research on the topic, as per Berg and Gigerenzer (2010), information of the sort presented is exceedingly rare, stating that "Notably missing is investigation of whether people who deviate from axiomatic rationality face economically significant losses" (p. 133) and "the normative interpretation of deviations as mistakes does not follow from an empirical investigation linking deviations to negative outcomes" (p. 150). However, the results here are consistent with the meta-analytic research showing a reliably negative relationship between performance and procrastination (Steel, 2007) as well as research connecting procrastination to diminished health and reduced financial success (e.g., Mehrabian, 2000; Elliot, 2002; Sirois et al., 2003). When people report that they tend to put off despite expecting to be worse off, their expectations are often borne out.

Explaining Procrastination

There are several competing theories of procrastination, especially that procrastination is caused by perfectionism (e.g., Egan et al., 2011; Mohamadi et al., 2012). Here, we conducted an explicit test of Temporal Motivation Theory (Steel and König, 2006), which decomposes procrastination into expectancy, value and sensitivity to time related variables. Together, these variables account for approximately 57% of the variance at the trait level and their effect on observed delay is indeed mediated by procrastination. Furthermore, as predicted by Temporal Motivation Theory and confirmed by the multilevel analysis, procrastinators were especially vulnerable to difficult and less enjoyable tasks, as operationalized by grievance complexity. Those low in procrastination were far less affected by aversive task characteristics while those high in procrastination increasingly tended to delay. Given that procrastination is associated with reduced self-efficacy, these results are also consistent with Beck and Schmidt (2012) experimental research on self-efficacy, resource allocation, and goal difficulty. The more difficult a task becomes, the fewer resources are allocated to it by those lacking self-efficacy. Similarly, Louro et al. (2007) argue that resource allocation is a function of goal proximity and the valence of goal relevant emotions. Taken together, we are starting to have a firm understanding of when as well as why procrastination occurs.

The results from our investigation into self-regulatory skills and perfectionism spanned the range of outcomes: positive, negative and neutral. Notably, the propensity to procrastinate was incrementally predicted by self-regulatory skills, particularly Organization. In the other direction, Multitasking is confirmed as a largely dysfunctional work strategy, associated with procrastination, longer delays and being susceptible to temptations. In total, trait and self-regulatory variables accounted for an impressive 73% of the variance in procrastination in Study One and 58% in Study Two (which did not assess Organization). This almost exactly duplicates Steel et al. (2018) finding; a few variables accounted for 74% of the variance in procrastination, drastically limiting the amount of residual variance left to predict and other variables' potential unique impact, such as perfectionism. As stressed here as well as by Xie et al. (2018), perfectionism's connection to procrastination accounts for no incremental variance after these mediating processes are taken into account.

Again, the results stress the need to include time related variables and longitudinal perspectives both in motivational theory and practice. For example, Pepper and Gore (2014), also

using a Temporal Motivation Theory frame, found that the excessive application of Expectancy × Value formulations has resulted in largely ineffective compensation plans, where existing "long-term incentives are not an efficient way of motivating senior executives, irrespective of national culture" (p. 26). In short, there are considerable costs in employing an overly stripped down or simplified motivational model.

Limitations and Future Research

This research underscores many of the same points recently made in the motivational field (Fishbach and Zhang, 2009; Mitchell et al., 2009; Lord et al., 2010), such as Beck and Schmidt (2012) who discuss how we should view "motivation as a process of decision-making over time" and that "goal difficulty is a critical determinant of motivational processes" (p. 206). Accordingly, future research should continue along these lines, looking at motivation dynamically. We consider here a potential research program that facilitates this pursuit, which also addresses inherent limitations with this study.

One of the limitations of this study comes from its strength, our realistic or NDM setting (Lipshitz et al., 2001; Klein, 2008). Our use of arbitrators enabled a rigorous, unobtrusive, temporal measure of the work performed. It also makes replication extraordinarily difficult, especially without collaboration from within the sample frame, that is, fellow arbitrators. Even with a collaborator (i.e., two of the authors are active within the arbitration community), acquiring participants while keeping the assessment battery brief enough and with sufficient face validity to ensure completion was a reoccurring issue. We struck a balance in assessment by using a combination of context specific as well as more general scales (e.g., as for procrastination). Despite this issue, we did manage to administer a large assessment battery of up to 200 items and were able to replicate many of the results in Study Two with a much larger sample. Still, for this type of multilevel design, Study One represents a large number of participants and cases (e.g., Claessens et al., 2010).

Finally, using archival case data limits the information available from these cases to what has been recorded. For example, we are unable to examine state level manifestations of expectancy, value and sensitivity to time that the arbitrators actually experience as they encounter each individual case. Accordingly, these issues are somewhat unavoidable, inherent to constraints that most field studies with measures of actual behavior encounter (Baumeister et al., 2007). However, that the available case information exists is itself notable. The arbitration cases themselves are part of the public record within the Canadian system but are only sporadically available in other countries, such as the United States. To our knowledge, there are no other comparable groups of professionals where people are performing essentially the same or easily comparable but measurable "slippery deadline" task frequently over potentially several years. However, there is a promising non-professional option to explore.

Steel and König (2006) recommend investigating motivation dynamically with courses taught through a computerized personal system of instruction (C-PSI). As they review, a C-PSI course allows: "hundreds of students simultaneously working toward completing a university course at their own pace, allowing choice and thus motivated behavior. Furthermore, progress is assessed at a large number of data points as the course is broken down into numerous assignments, all computer administered with completion precisely recorded. Similarly, a host of other observed and self-reported measures can be easily inserted into this framework" (p. 906–907). In short, we have a meaningful task, a "slippery deadline," and precise start and completion dates. As per the present study, this is ideal since the tight connection between observed delay and procrastination means, *in the absence of an accompanied early start*, observed delay over several tasks can be taken as a reasonable proxy of procrastination despite the lack of a formal assessment of irrationality. Previous use of the venue by Steel et al. (2001) established that C-PSI courses are rife with procrastination and other forms of self-regulatory failure.

Furthermore, there has been rapid growth of Massive Open Online Courses (MOOCs), such as those being offered by MIT, Harvard and Berkeley (Martin, 2012). With enrollment in the hundreds of thousands, rather than the hundreds, it allows for an ongoing and detailed investigation of self-regulation. Partly due to our choice of sample, our battery of self-regulatory measures was limited and a few measurement issues arose after contextualizing it to an arbitration setting (e.g., the reliability for the self-regulatory measure of Organization was lower than expected). Though we could touch on the importance of self-regulation, proper examination of self-regulation requires deep examination, befitting a topic that consists of "multiple processes and components that interact in complex ways" (Boekaerts, 2010, p. 71). MOOCs appear ideal for this purpose, given that their sample size and number allow for continuous and varied exploration (Diver and Martinez, 2015).

The benefit of a more detailed examination would be to isolate key proximal skills that influence goal striving but are also trainable. As Steel and Klingsieck (2016) emphasize, procrastination interventions should not focus on the neurotic procrastinator, which comprises perhaps 10% of all procrastinators, but customized to individuals' specific set of temptations, circumstances and target tasks. Since procrastination has separate expectancy, value and impulsiveness components, treatment should first proceed by identifying specific weaknesses in these areas and then targeting appropriate skills. For example, those specifically lacking self-efficacy will not necessarily respond to value interventions (e.g., interest enhancement) or impulsiveness interventions (e.g., attentional control). One size does not fit all. Online computerized courses will enable us to assess the interaction effect between prior need and the development of self-regulatory skills, rather easily if the self-regulatory interventions can also be administered as a C-PSI. If the massive and constantly renewing sample offered by MOOCs can be drawn upon, the dynamic study of motivation can be expected to advance quite rapidly. A particularly notable though early effort along these lines is Huang et al. (2021).

Finally, arbitrators represent some of the lowest scoring professions for procrastination, but even within this elite group

procrastination had an impact. In today's deadline strewn and temptation-soaked world, completely avoiding procrastination appears to be a rarity. As research such as Rinaldi et al. (2021) stress, this ubiquity reflects that the neurobiological roots of procrastination run through the brain's executive function, which we all have. Though this is consistent with Temporal Motivation Theory (Steel, 2011), we would benefit by moving beyond summary variables (e.g., impulsivity) and take a more detailed approach. By identifying the exact neural mechanisms that are impaired or at least operating less than optimally, new diagnostics and interventions to minimize procrastination are likely to emerge.

CONCLUSION

Members of the National Academy of Arbitrators – individuals at the pinnacle of their profession – are still substantively affected by procrastination. Having found procrastination in this venue, we likely will find it to exert a significant influence on any job where people can autonomously choose their work schedule, such as writers, entrepreneurs or independent salespeople as they all have considerable discretion over task completion. In particular, procrastination should become an increasing issue for senior management. For example, Spencer (1955) surveyed 950 company presidents and chief executives, finding that procrastination was the most troublesome problem reported and "It was also evident that personal procrastination was involved in scores of other problems they mentioned, even though the term was not used" (p. 83). Given procrastination's broad manifestation and evident importance, we should not underestimate the temporal nature of work behavior, which is affected by both task and individual variables.

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.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Haskayne School of Business, University of Calgary Conjoint Faculties Research Ethics Board. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DT and AP have contributed equally to this work. All authors contributed to the article and approved the submitted version.

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What Research Has Been Conducted on Procrastination? Evidence From a Systematical Bibliometric Analysis

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Procrastination is generally perceived as a common behavioral tendency, and there are a growing number of literatures to discuss this complex phenomenon. To elucidate the overall perspective and keep abreast of emerging trends in procrastination research, this article presents a bibliometric analysis that investigates the panorama of overviews and intellectual structures of related research on procrastination. Using the Web of Science Database, we collected 1,635 articles published between 1990 and 2020 with a topic search on "procrastination" and created diverse research maps using CiteSpace and VOS viewer. Bibliometric analysis in our research consists of category distribution, keyword co-occurrence networks, main cluster analysis, betweenness centrality analysis, burst detection analysis, and structure variation analysis. We find that most research has focused on students' samples and has discussed the definition, classification, antecedents, consequences and interventions to procrastination, whereas procrastination in diverse contexts and groups remains to be investigated. Regarding the antecedents and consequences, research has mainly been about the relationship between procrastination and personality differences, such as the five-factor model, temperament, character, emotional intelligence, and impulsivity, but functions of external factors such as task characteristics and environmental conditions to procrastination have drawn scant attention. To identify the nature and characteristics of this behavior, randomized controlled trials are usually adopted in designing empirical research. However, the predominant use of self-reported data collection and for a certain point in time rather than longitudinal designs has limited the validation of some conclusions. Notably, there have been novel findings through burst detection analysis and structure variation analysis. Certain research themes have gained extraordinary attention in a short time period, have evolved progressively during the time span from 1990 to 2020, and involve the antecedents of procrastination in a temporal context, theoretical perspectives, research methods, and typical images of procrastinators. And emerging research themes that have been investigated include bedtime procrastination, failure of social media self-control, and clinical interventions. To our knowledge, this is almost the first time to conduct systematically bibliometric analysis on the topic of procrastination and findings can provide an in-depth view of the patterns and trends in procrastination research.

Keywords: procrastination, co-citation analysis, intellectual structure, CiteSpace, bibliometric analysis

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INTRODUCTION

Procrastination is commonly conceptualized as an irrational tendency to delay required tasks or assignments despite the negative effects of this postponement on the individuals and organizations (Lay, 1986; Steel, 2007; Klingsieck, 2013). Poets have even written figuratively about procrastination, with such phrases as "*Procrastination is the Thief of Time,*" and "*Procrastination is the Art of Keeping Up with Yesterday*" (Ferrari et al., 1995). Literal meanings are retained today in terms of time management. The conceptualizations of procrastination imply inaction, or postponing, delaying, or putting off a decision, in keeping with the Latin origins of the term "pro-," meaning "forward, forth, or in favor of," and "-crastinus," meaning "tomorrow" (Klein, 1971). Time delay is just the behavioral reflection, while personality traits, cognitive and motivational process, as well as contextual conditions are in-depth inducements to procrastination. Procrastination can be viewed as purposive and irrational delay so as to miss the deadlines (Akerlof, 1991; Schraw et al., 2007).

Procrastination is believed to be a self-regulation failure that is associated with a variety of personal and situational determinants (Hen and Goroshit, 2018). Specifically, research suggests that task characteristics (e.g., unclear instructions, the timing of rewards and punishment, as well as task aversiveness), personality facets (e.g., the five-factor model, motivation, and cognition), and environmental factors (e.g., temptation, incentives, and accountability) are the main determinants of procrastination (Harris and Sutton, 1983; Johnson and Bloom, 1995; Green et al., 2000; Wypych et al., 2018). Procrastination can be an impediment to success, and may influence the individual's mood, and increase the person's anxiety, depression, and low self-esteem (Ferrari, 1991; Duru and Balkis, 2017). Furthermore, a person with procrastination is prone to poor performance, with lower exam scores, slower job promotions, and poorer health (Sirois, 2004; Legood et al., 2018; Bolden and Fillauer, 2020). Importantly, if policymakers postpone conducting their decision-making until after the proper timing, that procrastination can cause a significant and negative impact on the whole society, such as the cases with the COVID-19 pandemic management in some countries (Miraj, 2020).

In practice, procrastination is stable and complex across situations, ranging from students' academic procrastination, to staffs' work procrastination, to individuals' bedtime procrastination, to administrative behavior procrastination when government organizations face multiple tasks in national governance, and even to delayed leadership decision-making in crisis situations in global governance (Nevill, 2009; Hubner, 2012; Broadbent and Poon, 2015; Legood et al., 2018). As for science research, procrastination has attracted more and more attention and been studied extensively. Personally, possible explanations for emerging research focuses mainly consist of two aspects. On one hand, procrastination with high prevalence and obvious consequences highlights the importance to explore the complex phenomenon deeply, especially the meteoric rise in availability of information and communications technologies (ICTs) amplifies chronic procrastination, such as problematic social media use, smartphone addictions as well as mobile checking habit intrusion (Ferrari et al., 2007; Przepiorka et al., 2021; Aalbers et al., 2022). On the other hand, more and more basic and milestone research emerges in large numbers, which set the foundation for latecomer' further exploration toward procrastination. In particular, it can't be ignored the efforts of those productive authors in different periods to drive the knowledge development of procrastination.

Procrastination research has experienced tremendous expansion and diversification, but systematic and overview discussion is lacking. Several meta-analyses about procrastination have emerged, but they emphasize more on specific topics (Steel, 2007; Sirois et al., 2017; Malouff and Schutte, 2019). Furthermore, the number of newly published articles is increasing, so it becomes difficult to fully track the relevant domain literature. In order to grasp knowledge development about the fast-moving and complex research field, bibliometric analysis is necessary to construct diagram-based science mapping, so as to provide a comprehensive and intuitive reference for subsequent researchers. Thus, this article emphasizes on the following major research question: what is the intellectual base and structure of procrastination research? How does the emerging direction of procrastination develop? In our research, bibliometric analysis included the annual distribution of literature, distribution of categories, keyword co-occurrence networks, main research clusters, high citation betweenness centrality, and the strongest citation bursts, as well as the recent publications with transformative potential, in order to look back on the early development of procrastination research and look forward to the future transformation of that research. For both scholars and members of the public, this study can comprehensively enhance their understanding of procrastination and can provide overall perspectives for future research.

DATA AND METHODOLOGY

Bibliometric analysis is a quantitative method to investigate intellectual structures of topical field. On the basis of co-citation assumption that if two articles are usually cited together, then there are high associations between those articles, bibliometric analysis can reflect the scientific communicational structures holistically (Garfield, 1979; Chen et al., 2012). Bibliometric techniques, such as CiteSpace, VOSviewer, HistCite, can generate the science maps based on plenty of literature concerning certain domain. Through the process of charting, mining, analyzing, sorting, and displaying knowledge, science mapping can extract pivotal information from huge complex literature, present knowledge base and intellectual structure of a given field visually, then researchers even general individual can quickly grasp one subject's core structure, development process, frontier field and the whole knowledge framework (Chen, 2017; Widziewicz-Rzonca and Tytla, 2020). Bibliometric analysis is commonly regarded as a complementary method to traditional structured literature reviews such as narrative analysis and meta-analysis (Fang et al., 2018; Jiang et al., 2019). Traditional literature analysis tends to labor intensive with subjective preferences,

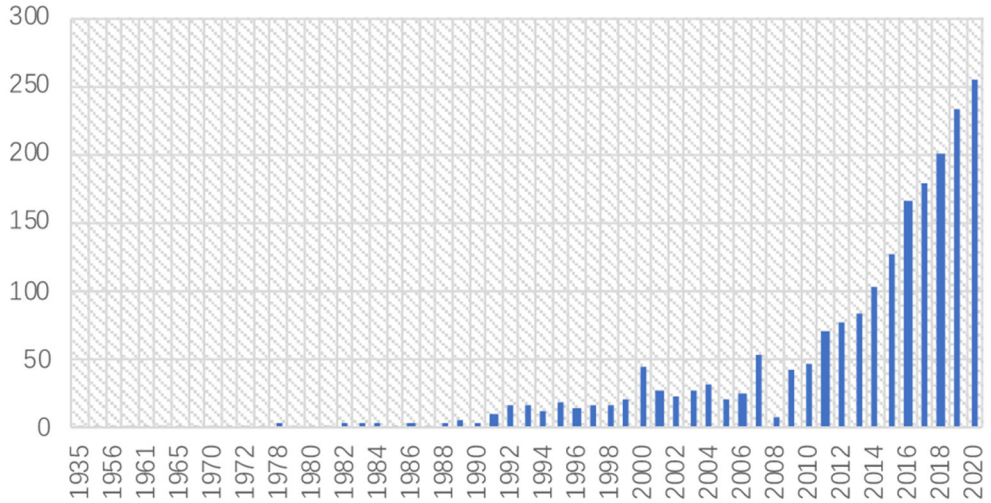

FIGURE 1 | Distribution of publications on the topic of procrastination, 1900-2020.

and faces difficulties in analyzing larger body of literature, whereas bibliometric analysis provides a more objective approach for investigating considerable literature's intellectual structure through statistical analysis and interactive visual exploration.

In order to master the characteristics of procrastination research, the study adopted the bibliometric software of CiteSpace and VOSviewer to analyze the literature on procrastination during the time period 1990–2020. The software tool VOSviewer is designed for creating maps of authors, journals, and keyword co-occurrences based on network data (van Eck and Waltman, 2010), whereas CiteSpace is applied to conduct co-citation analysis, including centrality betweenness analysis, burst detection, and the emerging trends of research (Chen, 2006, 2017). In our study, we adopted the CiteSpace (5.7.R1) and VOSviewer (1.6.15) software together. Specifically, co-citation analysis mainly depends on CiteSpace software, and co-occurrence analysis is conducted through VOS viewer (Markscheffel and Schroeter, 2021).

Though there is one similar bibliometrics analysis toward this topic (Tao et al., 2021), related research just focuses on academic procrastination, and mainly conducts co-occurrence analysis using VOSviewer, so as to there is a lack of analysis to core co-citation structures including high betweenness centrality articles, citation burst research and structure variation analysis. To offer insight into the intellectual structure of procrastination research, we further employ CiteSpace — a java application including bibliometric analysis, data mining algorithms and visualization methods developed by Chen — to visualize and elucidate vital trends and pivotal points about knowledge development.

To conduct our bibliometric analysis of procrastination research, we collected bibliographic records from the Web of Science Core Collection as of December 31, 2020. Web of Science is currently the most relevant scientific platform regarding systematic review needs, allowing for a "Topic" query, including searching a topic in the documents' "title", "abstract", "author keywords" and "keywords plus" of the documents being reviewed (Yi et al., 2020). A topic search strategy is broad enough to be used in science mapping (Olmeda-Gomez et al., 2019). Given the aim of the study, records were downloaded if they had the term "procrastination" in the "Topic" field. After restricting the type of publication to "Article" for the years 1900–2020, we had searched 2105 papers about procrastination research.

Figure 1 shows the yearly distribution of 2105 literature during 1900–2020, and it can be classified into three phases. In phase I (1900–1989), the annual number of publications never exceeded 10. In phase II (1990–2010), the annual quantity gradually increased from 11 papers in 1991 to 48 in 2010. The annual number of publications had begun to grow in this period, but remained below 50 papers yearly. In phase III (2011–2020), however, the procrastination research experienced a dramatic growth, with 255 literature in the year 2020. Although procrastination research appeared as early as 1900s, it had a stable total volume until the 1990s, when it developed sustained growth, and that growth became extraordinary during the 2010s. Therefore, this research emphasized centered on 1,635 literature that were published during the time span 1990–2020.

PANORAMIC OVERVIEW OF PROCRASTINATION RESEARCH

Category Distribution

Procrastination research has been attracting increasing attention from scholars, and it has been successfully integrated into various scientific fields. With the help of CiteSpace software, we present in **Figure 2** the timelines of the various disciplines that are involved in procrastination research, and the cumulative numbers of literature that have been published.

As **Figure 2** shows, the size of node on the horizontal lines represents the quantity of literature published. Node

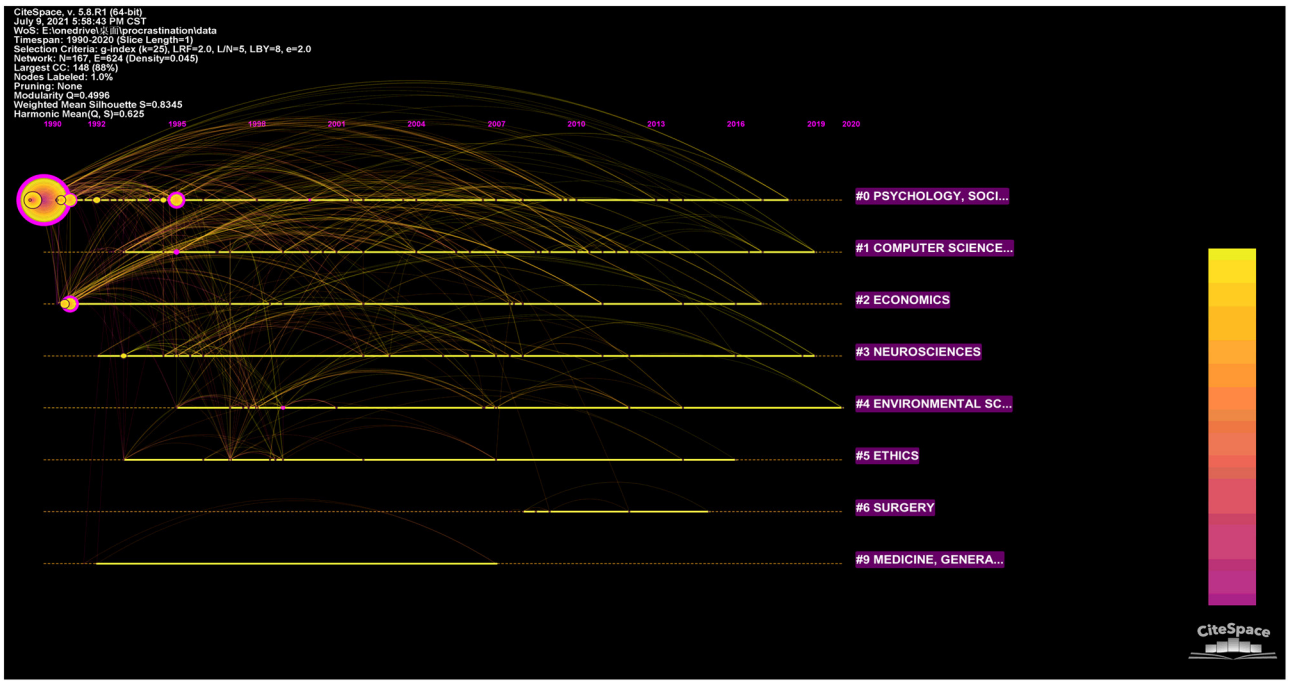

FIGURE 2 | Distribution of categories involved in procrastination research.

colors denote the range of years of occurrence, and purple outlining is an indication of those articles with prominent betweenness centrality, and red nodes present references with high citation burst (Chen, 2017). Besides, the uppermost line shows the timeline of different disciplines, and the numbers on the longitudinal lines describe the distinct categories of procrastination research, of which are arranged vertically in the descending order of cluster's size. Clusters are numbered from 0, i.e Cluster #0 is the largest cluster and Cluster #1 is the second largest one. Specifically, the earlier research about procrastination occurs in the Psychology and Social Science disciplines. Subsequently, research has expanded into Computer Science and Information Systems, Economics, the Neurosciences, the Environmental Sciences, Ethics, Surgery, and general Medicine. As the connections arc in the **Figure 2** presents, those categories #0 Psychology and Social Sciences, #1 Computer Science, and #2 Economics interact actively, but the interdisciplinary research about the remaining categories, such as #9 Medicine, #5 Ethics, and #4 Environmental Science, is not active.

Our analysis of the category distribution reveals two aspects of the characteristics about procrastination research. One, related research mostly has its roots in the Psychology and Social Science disciplines, and interdisciplinary research needs to be improved. And Two, the foundational literature dates back to the 1990s, and transformational exploration is currently needed in order to further develop the research on procrastination.

Keyword Co-occurrence Network: Core Contents

Analysis of co-occurring keywords is often used to obtain the content of research fields. Using the VOS viewer, we obtained a total of 5,203 keywords and created a co-occurrence network. As mentioned above, the size of a node represents the number of times that a specific keyword occurs. Several keywords turn up frequently, such as Procrastination, Performance, Academic Procrastination, Motivation, Personality, Self-regulation, Self-control, and Behavior. To create a readable map, the "minimum number of occurrences" is set to 20, and the final network includes 90 high-frequency keywords and five clusters with 2,650 links, as is shown in **Figure 3**.

Among the five clusters depicted in **Figure 3**, the blue cluster is mainly related to the definition of procrastination, with keywords such as Procrastination, Delay, Deadlines, Choice, Self-Control, and Implementation Intentions. Procrastination is a complex phenomenon, and previous research has elaborated on the core traits about procrastination from various dimensions. Mainstream views hold that procrastination can be defined as the intentional delay of work because of a self-regulation failure, time-management inefficiency, short-term benefits, a gap between intention and action (Tice and Baumeister, 1997; Steel, 2007; Pychyl and Flett, 2012; Klingsieck, 2013), or missing a deadline and causing negative outcomes (Johnson and Bloom, 1995; Howell and Watson, 2007; Sirois, 2021).

The cluster in red in **Figure 3** involves procrastination performance in relation to different life-domains, including

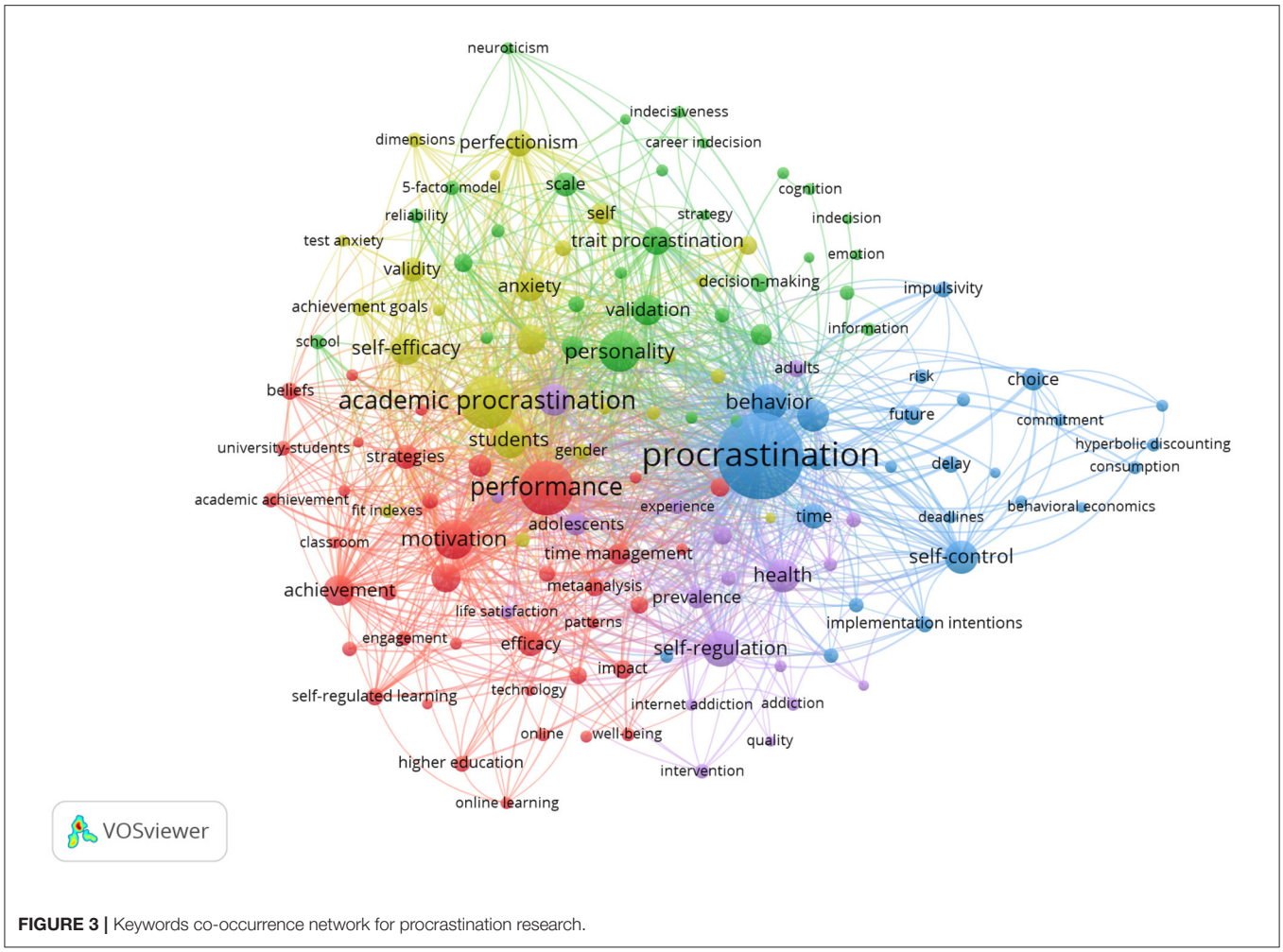

FIGURE 3 | Keywords co-occurrence network for procrastination research.

Academic Achievement, Life Satisfaction, Online Learning, and Technology Uses. Previous research has elaborated on procrastination as being negatively correlated with performance. However, intrinsic motivation, self-regulated learning, and time-management have been shown to relieve the procrastination behavior (Wolters, 2003; Howell and Watson, 2007; Baker et al., 2019).

The green cluster highlights traits associated with procrastination. Related research in that cluster mostly discusses the correlation between the five-factor model (neuroticism, extraversion, openness to experience, agreeableness, conscientiousness) and procrastination (Schouwenburg and Lay, 1995). In addition, personality traits including indecisiveness, indecision, and perfectionism have been elaborated upon (Klingsieck, 2013; Tibbett and Ferrari, 2019). Furthermore, to measure the trait of procrastination itself, various scales have been developed, such as the General Procrastination Scale, Decisional Procrastination Questionnaire, Procrastination at Work Scale, Irrational Procrastination Scale, Adult Inventory of Procrastination Scale and so on (Lay, 1986; Ferrari et al., 1995; Steel, 2010; Metin et al., 2016). The validity and reliability of those scales have also been investigated fully.

The cluster presented in yellow depicts studies that focuses on academic procrastination, and especially those that discuss the antecedents of the prevalent behavior, such as Anxiety, Perfectionism, Self-efficacy, Depression, and Stress (Schraw et al., 2007; Goroshit, 2018). Owing to their accessibility for use as a research sample, a large body of procrastination research has chosen students in an academic setting as the research objects. Researchers have found that academic procrastination is an impediment to academic performance, especially for very young students. Notably, too, female students may perform lower levels of academic procrastination than males do.

The last cluster, presented in purple, relates to chronic procrastination's involvement in health and addiction, for either adults or adolescents. Discussion about chronic procrastination is growing, and interventions can be effective in relieving this behavior.

From the analysis of co-occurrence keywords, we can infer that procrastination research has been developing steadily. The fundamental discussion has become more adequate and persuasive in regard to the definition, the individual differences, and the antecedents of procrastination, and a discussion of how to relieve the behavior has begun.

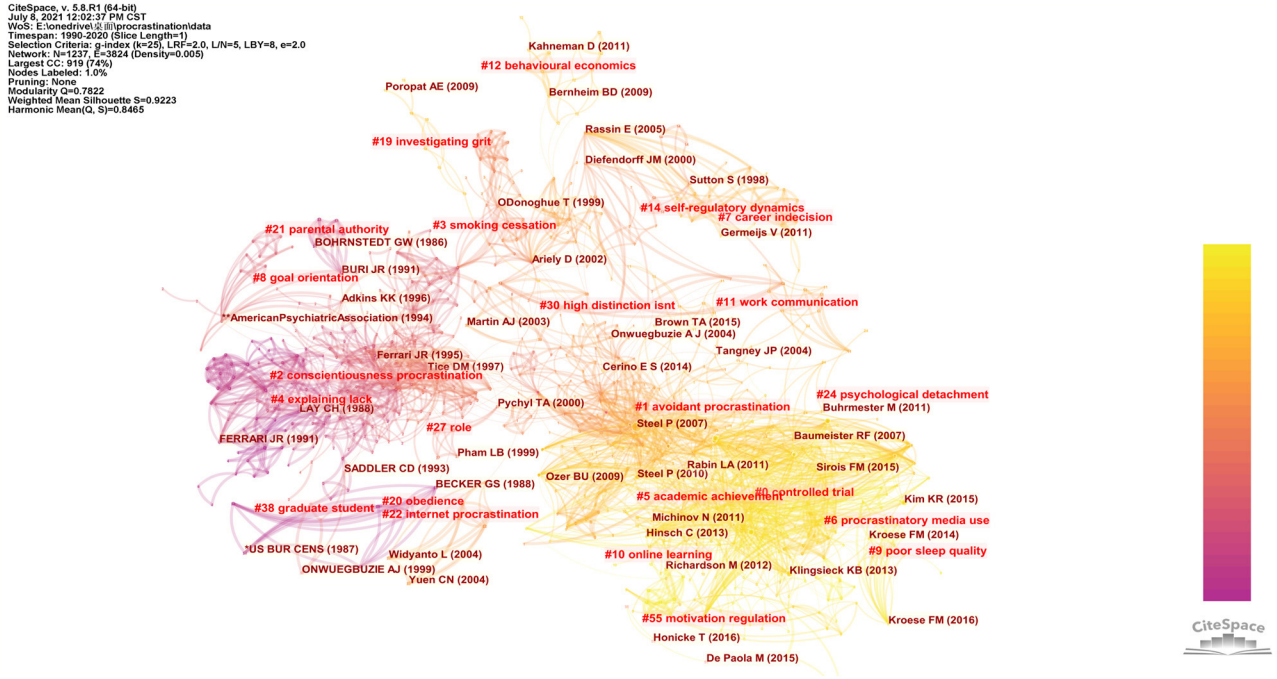

FIGURE 4 | Landscape view of co-citation network of procrastination research.

Main Research Cluster: Core Theme and Hot Topics

Comparing to keyword co-occurrence network analyses, cluster analysis can help us grasp the primary themes in procrastination research. Clusters are based on the assumption that if two references are often cited together, they may be associated in some way (Chen et al., 2012; Pan et al., 2019). Eventually, related references shape diverse co-citation networks. Clustering is a procedure to classify co-cited references into groups, with references in the same clusters being tightly connected with each other but loosely associated with other clusters (Chen et al., 2010).

Based on the references of the top 50 articles with the most citations every year (if the number was less than 50 in a certain year, then all of the articles were combined), the final network contained 982 references and we were able to develop the final cluster landscape. Two procedures are used to label each cluster: (1) retrieval of keywords from the citing articles using the log likelihood ratio, and (2) retrieval of terms contained in the cited articles with latent semantic indexing (Olmeda-Gomez et al., 2019). In our research, we adopted the log-likelihood ratio (LLR) method to label the clusters automatically. Given the related structural and time-based values, articles in the co-citation network are assigned to each cluster. Eventually, the network was divided into 23 co-citation clusters.

In addition, two critical parameters, silhouette and modularity, are used to measure whether clusters are available and whether they are well-constructed. Silhouette indicates the homogeneity of clusters, whereas modularity measures whether the network is reasonably divided into independent clusters. The silhouette value ranges from −1 to 1, and the modularity score ranges from 0 to 1. When values of the two metrics are high, the co-citation network is well-constructed (Chen et al., 2010; Widziewicz-Rzonca and Tytla, 2020). As is shown in **Figure 4**, the mean silhouette score of 0.9223 suggested that the homogeneity of these clusters was acceptable, and the modularity score of 0.7822 indicated that the network was reasonably divided.

In our research, we summed the largest nine clusters. As is shown in **Table 1**, the silhouette value for all clusters was higher than 0.8, suggesting the references in each cluster were highly homogeneous. The labels of these clusters were controlled trial, avoidant procrastination, conscientiousness procrastination, smoking cessation, explaining lack, academic achievement, procrastinatory media use, career indecision, and goal orientation.

In **Table 1**, the year in the far-right column indicated the average year when the reference was cited. Ranking the clusters by the mean cited year, we can follow the development of research themes. During the 1990s, research themes focused on discussions about the antecedents of procrastination. For example, Lay (1988) discussed that the self-regulation model cannot explain procrastination fully, and errors in estimations of the time taken to complete a task may be attributed to procrastination. Procrastinators were thought to tend to lack conscientiousness and goal orientation as well as to

TABLE 1 | Summary of the nine largest clusters in procrastination research.

Cluster ID	Size	Silhouette	Label (LLR)	Mean (Year Cited)
0	182	0.855	Controlled trial	2014
1	148	0.836	Avoidant procrastination	2005
2	144	0.938	Conscientiousness procrastination	1994
3	72	0.989	Smoking cessation	2000
4	65	0.97	Explaining lack	1988
5	58	0.903	Academic achievement	2009
6	33	0.988	Procrastinatory media use	2013
7	31	0.99	Career indecision	2006
8	28	0.981	Goal orientation	1995

be motivated by neurotic avoidance (Ferrari et al., 1995; Elliot and Harackiewicz, 1996). Besides, procrastination was prevalent throughout our lifespan, and empirical research on procrastination conducted through controlled trials had considered various settings or scenarios, such as academic procrastination, smoking cessation, career indecision, and in the most recent years, media use (Klassen et al., 2008; Germeijs and Verschueren, 2011; Du et al., 2019). Because procrastination was negatively associated with performance, life satisfaction, health and well-being, research on procrastination avoidance and intervention, including strengths-based training and cognitive behavioral therapy had attracted the most attention from scholars (van Eerde, 2003; Balkis and Duru, 2016; Visser et al., 2017).

INTELLECTUAL STRUCTURE OF PROCRASTINATION RESEARCH

Co-citation analysis and clustering analysis form the cornerstone for bibliometric investigation (Olmeda-Gomez et al., 2019), especially for the microscopic intellectual structures of the science, such as betweenness centrality, burst detection, and structural variation analysis (Pan et al., 2019). Based on the cited references network during the period of 1990–2020, we generated a landscape visualization of intellectual structures about procrastination research. The section consists of three parts: (1) Betweenness Centrality Analysis captures the bridge nodes, which represents the landmark and pivotal literature of a scientific field (Freeman, 1978). (2) Burst Detection Analysis is used to detect the emergent and sharp increases of interest in a research field (Kleinberg, 2003), which is a useful method for easily tracing the development of research focus and research fronts. (3) Structural Variation Analysis (SVA) is an optional measurement to identify whether newly published articles have the potential to transform the citation network in the latest years. Newly published articles initially have fewer citations and may be overlooked. To overcome the limitation, structural variation analysis often employs zero-inflated negative binomial (ZINB) and negative binomial (NB) models to detect these transformative and potential literature (Chen, 2013).

Betweenness Centrality Analysis

Literature with high betweenness centrality tends to represent groundbreaking and landmark research. On the basis of our co-citation network on procrastination research for the period 1990–2020, we chose the top 10 articles to explore (see **Supplementary Material** for details). Related research mainly focuses on three areas.

Definition and Classification of Procrastination

Procrastination is described as the postponement of completion of a task or the failure to meet deadlines, even though the individual would meet adverse outcomes and feel uncomfortable as a result (Johnson and Bloom, 1995). Extracting from authoritative procrastination scales, Diaz-Morales et al. (2006) proposed a four-factor model of procrastination: dilatory behaviors, indecision, lack of punctuality, and lack of planning. Procrastination is commonly considered to be a pattern of self-regulation failure or self-defeating behavior (Tice and Baumeister, 1997; Sirois and Pychyl, 2013).

The most popular classification is the trinity of procrastination: decisional, arousal, and avoidant procrastination (Ferrari, 1992). Using the General Behavioral Procrastination Scale and Adult Inventory of Procrastination Scale, Ferrari et al. (2007) measured the difference between arousal and avoidant procrastination, and they elaborated that those two patterns of procrastination showed similarity and commonality across cultural values and norms. However, by conducting a meta-analytic review and factor analyses, Steel (2010) found that evidence for supporting the tripartite model of procrastination may not be sufficient. Research has reached a consensus about the basic definition of procrastination, but how to classify procrastination needs further discussion.

Procrastination Behavior in a Temporal Context

Procrastination is related to time management in its influence on one's behavior. Non-procrastinators or active procrastinators have better time control and purposive use of time (Corkin et al., 2011). However, time management is an obstacle to procrastinators. From the temporal disjunction between present and future selves, Sirois and Pychyl (2013) pointed out that procrastinators tended to give priority to short-term mood repair in the present, even though their future self would pay for the inaction. Similarly, in a longitudinal study Tice and Baumeister (1997) pointed out that maladjustment about benefits-costs in participants' timeframe shaped their procrastination. When a deadline is far off, procrastination can bring short-term benefits, such as less stress suffering and better health, whereas early benefits are often outweighed by possible long-term costs, including poor performance, low self-esteem, and anxiety. These

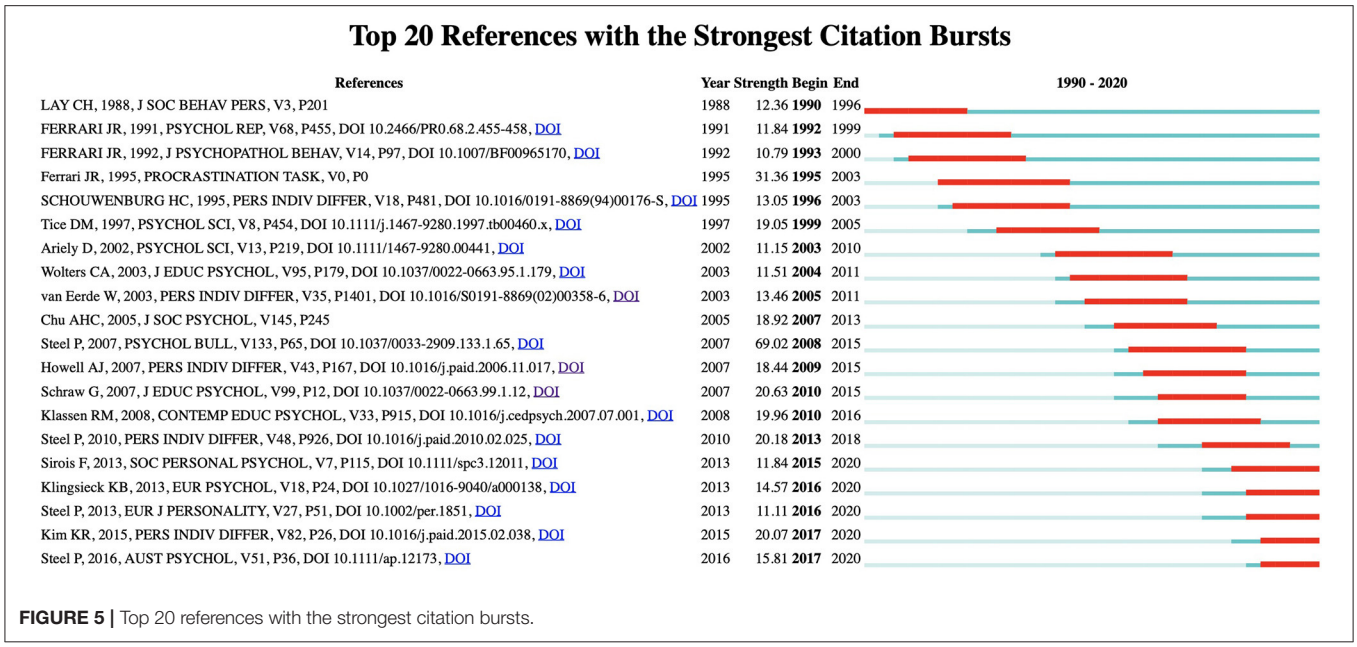

FIGURE 5 | Top 20 references with the strongest citation bursts.

viewpoints confirm that procrastination is a form of self-regulation failure, and that it involves the regulation of mood and emotion, as well as benefit-cost tradeoffs.

Causes of and Interventions for Procrastination

Procrastination shows significant stability among persons across time and situations. Predictors of procrastination include personality traits, task characteristics, external environments, and demographics (Steel, 2007). However, typically, empirical research has mostly focused on the relationship between the five-factor model and procrastination behavior. Johnson and Bloom (1995) systematically discussed five factors of personality to variance in academic procrastination. Research also had found that facets of conscientiousness and neuroticism were factors that explained most procrastination. In alignment with these findings above, Schouwenburg and Lay (1995) elaborated that procrastination was largely related to a lack of conscientiousness, which was associated with six facets: competence, order, dutifulness, achievement-striving, self-discipline, and deliberation. Meanwhile, impulsiveness (a facet of neuroticism) has some association with procrastination, owing to genetic influences (Gustavson et al., 2014). These discussions have established a basis for research about personality traits and procrastination (Flett et al., 2012; Kim et al., 2017).

To relieve procrastination, time management (TM) strategies and clinical methods are applied in practice. Glick and Orsillo (2015) compared the effectiveness of those interventions and found that acceptance-based behavior therapies (ABBTs) were more effective for chronic procrastinators. Regarding academic procrastination, Balkis (2013) discussed the role of rational beliefs in mediating procrastination, life satisfaction, and performance. However, there is no "Gold Standard" intervention for procrastination. How to manage this complex behavior needs further investigation.

Burst Detection Analysis

A citation burst indicates that one reference has gained extraordinary attention from the scientific community in a short period of time, and thus it can help us to detect and identify emergent research in a specialty (Kleinberg, 2003). A citation burst contains two dimensions: the burst strength and the burst status duration. Articles with high strength values can be considered to be especially relevant to the research theme (Widziewicz-Rzonca and Tytla, 2020). Burst status duration is labeled by the red segment lines in **Figure 5**, which presents active citations' beginning year and ending year during the period 1990-2020. As can be seen in **Figure 5**, we ranked the top 20 references (see **Supplementary Material** for details) with the strongest citation bursts, from the oldest to the most recent.

To systematically investigate the active areas of procrastination research in different time periods, we divided the study's overall timespan into three time periods. During the period 1990 through 1999, there were six references with high citation bursts, with two of them by Ferrari and a third by Ferrari, Johnson, and McCown. Subsequently, in 2000 through 2009, there were eight reference bursts, and the meta-analysis and theoretical review by Steel (2007) had the highest citation burst among those 20 references. From the period 2010 through 2020, six references showed high citation bursts.

Period I (1990–1999): Preliminary Understanding of Procrastination's Antecedents

How one defines procrastination is important to interventions. During the early period of procrastination research, scholars

paid significant attention to define procrastination and discuss its antecedents. Time delay in completing tasks constitutes the vital dimension that distinguishes procrastination behavior, and that distinction has set the foundation for future exploration of the behavior. Lay (1988) found that errors in estimations of time led to procrastination, then identified two types of procrastinators: pessimistic procrastinators and optimistic ones, according to whether one is optimistic or pessimistic about judgments of time. In addition, the timeframe or constraint scenario influences one's behavioral choices. Procrastinators tend to weigh short-term benefits over long-term costs (Tice and Baumeister, 1997).

However, time delay is just a behavioral representation, and personality traits may be in-depth inducements to procrastination behavior (Ferrari, 1991; Ferrari et al., 1995). Schouwenburg and Lay (1995) empirically studied and elaborated upon the relationship between the five-factor model and procrastination facing a sample of students, and their findings showed consistency with research by Ferrari (1991) which demonstrated that the trait facets of lacking conscientiousness and of neurotic avoidance were associated with procrastination. In addition, Ferrari (1992) evaluated two popular scales to measure procrastination: the General Procrastination (GP) scale and the Adult Inventory for Procrastination (AIP) scale. Regarding the measurement of procrastination, a variety of scales have been constructed to further enhance the development of procrastination research.

Period II (2000–2009): Investigation of Cognitive and Motivational Facets and Emergence of Various Research Methods

During period II, procrastination research with high citation bursts focused largely on two dimensions: behavioral antecedences and empirical methods. On one hand, discussions about cognitive and motivational antecedents spring up. A series of studies find that cognitive and motivational beliefs, including goal orientation, perceived self-efficacy, self-handicapping, and self-regulated learning strategies, are strongly related to procrastination (Wolters, 2003; Howell and Watson, 2007; Klassen et al., 2008). Specifically, Howell and Watson (2007) examined the achievement goal framework with two variables, achievement goal orientation and learning strategies usage, in which four types of goal orientation can be derived by the performance vs. mastery dimension and the approach vs. avoidance dimension. Their research found that procrastination was attributed to a mastery-avoidance orientation, whereas it was adversely related to a mastery-approach orientation. Moreover, Chu and Choi (2005) identified two types of procrastinators, active procrastinators versus passive procrastinators, in terms of the individual's time usage and perception, self-efficacy beliefs, motivational orientation, stress-coping strategies, and final outcomes. This classification of procrastinators has aroused a hot discussion about procrastination research (Zohar et al., 2019; Perdomo and Feliciano-Garcia, 2020). Cognitive and motivational antecedents are complementary to personality traits, and the antecedents and traits together reveal the complex phenomenon.

In addition, there are various research methods being applied in the research, such as meta-analyses and grounded theory. Having the strongest citation burst in period II, research that was based on a meta-analysis of procrastination by Steel (2007) elaborated on temporal motivation theory (TMT). Temporal motivational theory provides an innovative foothold for understanding self-regulation failure, using four critical indicators: expectancy, value, sensitivity to delay, and delay itself. Similarly, van Eerde (2003) conducted a meta-analysis to examine the relationship between procrastination and personality traits, and proposed that procrastination was negatively related to conscientiousness and self-efficacy, but was also actively associated with self-handicapping. Procrastinators commonly set deadlines, but research has found that external deadlines may be more effective than self-imposed ones (Ariely and Wertenbroch, 2002). Furthermore, Schraw et al. (2007) constructed a paradigm model through grounded theory to analyze the phenomenon of academic procrastination, looking at context and situational conditions, antecedents, phenomena, coping strategies, and consequences. These diverse research methods are enhancing our comprehensive and systematical understanding of procrastination.

Period III (2010–2020): Diverse Focuses on Procrastination Research

After nearly two decades of progressive developments, procrastination research has entered a steady track with diverse current bursts, on topics such as type distinction, theoretical perspective, temporal context, and the typical image of procrastinators. Steel (2010) revisited the trinity of procrastination — arousal procrastinators, avoidant procrastinators, and decisional procrastinators — and using the Pure Procrastination Scale (PPS) and the Irrational Procrastination Scale (IPS), he found that there was no distinct difference among the three types. Regarding research settings, a body of literature has focused on academic procrastination in-depth, and that literature has experienced a significant citation burst (Kim and Seo, 2015; Steel and Klingsieck, 2016). For example, academic procrastination is associated more highly with performance for secondary school students than for other age groups.

Notably, theoretical discussions and empirical research have been advancing synchronously. Klingsieck (2013) investigated systematic characteristics of procrastination research and concluded that theoretical perspectives to explain the phenomenon, whereas Steel and Ferrari (2013) portrayed the "typical procrastinator" using the variables of sex, age, marital status, education, community location, and nationality. Looking beyond the use of time control or time perception to define procrastination, Sirois and Pychyl (2013) compared the current self and the future self, then proposed that procrastination results from short-term mood repair and emotion regulation with the consequences being borne by the future self. In line with the part of introduction, in the last 10 years, research on procrastination has flourished and knowledge about this complex phenomenon has been emerging and expanding.

Structure Variation Analysis

Structure variation analysis (SVA) can predict the literature that will have potential transformative power in the future. Proposed by Chen (2012), structure variation analysis includes three primary metrics — the modularity change rate, cluster linkage, and centrality divergence — to monitor and discern the potential of newly published articles in specific domains. The modularity change rate measures the changes in and interconnectivity of the overall structure when newly published articles are introduced into the intellectual network. Cluster linkage focuses on these differences in linkages before and after a new between-cluster link is added by an article, whereas centrality divergence measures the structural variations in the divergence of betweenness centrality that a newly published article causes (Chen, 2012; Hou et al., 2020). The values of these metrics are higher, and the newly published articles are expected to have more potential to transform the intellectual base (Hou et al., 2020). Specifically, cluster linkage is a direct measure of intellectual potential and structural change (Chen, 2012). Therefore, we adopted cluster linkage as an indicator by which to recognize and predict the valuable ideas in newly published procrastination research. These top 20 articles with high transformative potential that were published during the period 2016-2020 were listed (see **Supplementary Material** for details). Research contents primarily consist of four dimensions.

Further Investigations Into Academic Procrastination

Although procrastination research has drawn mostly on samples of students, innovative research contents and methods have been emerging that enhance our understanding of academic procrastination. In the past five years, different language versions of scales have been measured and validated (Garzon Umerenkova and Gil-Flores, 2017a,b; Svartdal, 2017; Guilera et al., 2018), and novel research areas and contents have arisen, such as how gender difference influences academic procrastination, what are the effective means of intervention, and what are the associations among academic procrastination, person-environment fit, and academic achievement (Balkis and Duru, 2016; Garzon Umerenkova and Gil-Flores, 2017a,b; Goroshit, 2018). Interestingly, research has found that females perform academic procrastination less often and gain better academic achievements than males do (Balkis and Duru, 2017; Perdomo and Feliciano-Garcia, 2020).

In addition, academic procrastination is viewed as a fluid process. Considering the behavior holistically, three different aspects of task engagement have been discussed: initiation, completion, and pursuit. Vangsness and Young (2020) proposed the metaphors of "turtles" (steady workers), "task ninjas" (precrastinators), and "time wasters" (procrastinators) to elaborate vividly on task completion strategies when working toward deadlines. Individual differences and task characteristics can influence one's choices of a task-completion strategy. To understand the fluid and multifaceted phenomenon of procrastination, longitudinal research has been appearing. Wessel et al. (2019) observed behavioral delay longitudinally through tracking an undergraduate assignment over two weeks to reveal how passive and active procrastination each affected assignment completion.

Relationships Between Procrastination and Diverse Personality Traits

In addition to the relationship between procrastination and the five-factor model, other personality traits, such as temperament, character, emotional intelligence, impulsivity, and motivation, have been investigated in connection with procrastination. Because the five-factor model is not effective for distinguishing the earlier developing temperamental tendencies and the later developing character traits, Zohar et al. (2019) discussed how temperament and character influence procrastination in terms of active and passive procrastinators, and revealed that a dependable temperament profile and well-developed character predicted active procrastination.

Procrastination is commonly defined as a self-regulation failure that includes emotion and behavior. Emotional intelligence (EI) is an indicator with which to monitor one's feelings, thinking, and actions, and hot discussions about its relationship with procrastination have sprung up recently. Sheybani et al. (2017) elaborated on how the relationship between emotional intelligence and the five-factor model influence decisional procrastination on the basis of a students' sample. As a complement to the research above, Wypych et al. (2018) explored the roles of impulsivity, motivation, and emotion regulation in procrastination through path analysis. Motivation and impulsivity reflecting a lack of value, along with delay discounting and lack of perseverance, are predicators of procrastination, whereas emotion regulation, especially for suppression of procrastination, has only appeared to be significant in student and other low-age groups. How personality traits influence procrastination remains controversial, and further research is expected.

Procrastination in Different Life-Domains and Settings

Newly published research is paying more attention to procrastination in different sample groups across the entire life span. Not being limited to student samples, discussions about procrastination in groups such as teachers, educated adults, and workers have been emerging. With regard to different life domains, the self-oriented domains including health and leisure time, tend to procrastinate, whereas parenting is low in procrastination among highly educated adults. Although the achievement-oriented life domains of career, education, and finances are found with moderate frequency in conjunction with procrastination, these three domains together with health affect life the most (Hen and Goroshit, 2018). Similarly, Tibbett and Ferrari (2019) investigated the main regret domains facing cross-cultural samples, so as to determine which factors increased the likelihood of identifying oneself as a procrastinator. Their research found that forms of earning potential, such as education, finances, and career, led participants to more easily label themselves as procrastinators. Procrastination can lead to regret, and this research adopted reverse thinking to discuss the antecedents of procrastination.

In addition to academic procrastination, research about the behavior in diverse-context settings has begun to draw scholars' attention. Nauts et al. (2019) used a qualitative study to investigate why people delay their bedtime, and the study identified three forms of bedtime procrastination: deliberate procrastination, mindless procrastination, and strategic delay. Then, those researchers proposed coached interventions involving time management, priority-setting skills, and reminders according to the characteristics of the bedtime procrastination. Interestingly, novel forms of procrastination have been arising in the attention-shortage situations of the age of the internet, such as social media self-control failure (SMSCF). Du et al. (2019) found that habitual checking, ubiquity, and notifications were determinants for self-control failures due to social media use, and that finding provided insight into how to better use ICTs in a media-pervasive environment. Moreover, even beyond those life-related-context settings, procrastination in the workplace has been further explored. Hen (2018) emphasized the factor of professional role ambiguity underlying procrastination. Classification of procrastination context is important for the effectiveness of intervention and provides us with a better understanding of this multifaceted behavior.

Interventions to Procrastination

Overcoming procrastination is a necessary topic for discussion. Procrastination is prevalent and stable across situations, and it is commonly averse to one's performance and general well-being. Various types of interventions are used, such as time management, self-management, and cognitive behavioral therapy. To examine the effectiveness of those interventions, scholars have used longitudinal studies or field experimental designs to investigate these methods of intervention for procrastination. Rozental et al. (2017) examined the efficacy of internet-based cognitive behavior therapy (ICBT) to relieve procrastination, from the perspective of clinical trials. Through a one-year follow-up in a randomized controlled trial, researchers found that ICBT could be beneficial to relieve severe, chronic procrastination. Taking the temporal context into consideration, Visser et al. (2017) discussed a strengths-based approach — one element of the cognitive behavioral approach — that showed greater usefulness for students at an early stage of their studies than it did at later ages. Overall, research on the effectiveness of intervention for procrastination is relatively scarce.

DISCUSSION AND CONCLUSION

Discussion on Procrastination Research

This article provides a systematic bibliometric analysis of procrastination research over the past 30 years. The study identifies the category distribution, co-occurrence keywords, main research clusters, and intellectual structures, with the help of CiteSpace and VOS viewer. As is shown in **Figure 6**, the primary focuses for research themes have been on the definition and classification of procrastination, the relationships between procrastination and personality traits, the influences brought by procrastination, and how to better intervene in this complex phenomenon.

Those contents have built the bases for procrastination research, but determining how those bases are constructed is important to the development of future research. Therefore, this article primarily discusses three aspects of intellectual structure of procrastination research: betweenness centrality, burst detection, and structural variation analysis. From the betweenness centrality analysis, three research themes are identifiable and can be generally summarized as: definition and classification of procrastination, procrastination behavior in a temporal context, and causes and interventions for procrastination.

However, procrastination research themes have evolved significantly across the time period from 1990–2020. Through burst detection analysis, we are able to infer that research has paid extraordinary attention to diverse themes at different times. In the initial stage, research is mainly about the antecedents of procrastination from the perspectives of time-management, self-regulation failure, and the five-factor model, which pays more attention to the behavior itself, such as delays in time. Subsequently, further discussions have focused on how cognitive and motivational facets such as goal orientation, perceived self-efficacy, self-handicapping, as well as self-regulated learning strategies influence procrastination. In the most recent 10 years, research has paid significant attention to expanding diverse themes, such as theoretical perspectives, typical images of procrastinators, and procrastination behavior in diverse temporal contexts. Research about procrastination has been gaining more and more attention from scholars and practitioners.

To explore newly published articles and their transformative potential, we conduct structural variation analysis. Beyond traditional research involving academic procrastination, emerging research themes consist of diverse research settings across life-domains, such as bedtime procrastination, social media self-control failure, procrastination in the workplace, and procrastination comparisons between self-oriented and achievement-oriented domains. Furthermore, novel interventions from the perspective of clinical and cognitive orientations to procrastination have been emerging in response to further investigation of procrastination's antecedents, such as internet-based cognitive behavior therapy (ICBT) and the strengths-based approach.

Conclusions and Limitations

In summary, research on procrastination has gained increasing attention during 1990 to 2020. Specifically in **Figure 7**, research themes have involved in the definition, classification, antecedents, consequences, interventions, and diverse forms of procrastination across different life-domains and contexts. Furthermore, empirical research has been conducted to understand this complex and multifaceted behavior, including how best to design controlled trial experiments, how to collect and analyze the data, and so on.

From the perspective of knowledge development, related research about procrastination has experienced tremendous expansion in the last 30 years. There are three notable features to describe the evolutionary process.

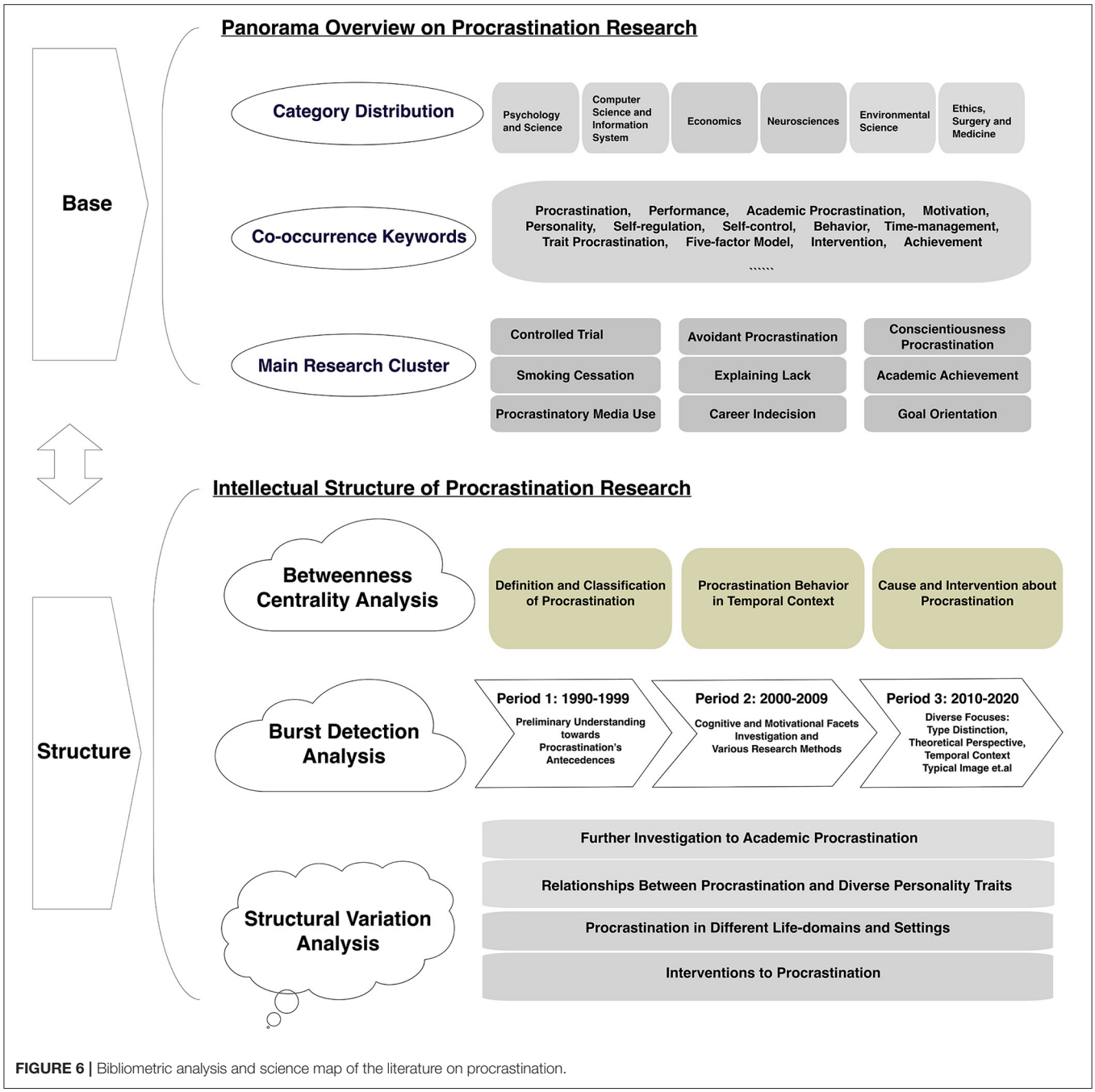

FIGURE 6 | Bibliometric analysis and science map of the literature on procrastination.

First, research focuses are moving from broader topics to more specific issues. Prior research mostly explored the definition and antecedents of procrastination, as well as the relationship between personality traits and procrastination. Besides, earlier procrastination research almost drew on students' setting. Based on previous research above, innovative research starts to shed light on procrastination in situation-specific domains, such as work procrastination, bedtime procrastination, as well as the interaction between problematic new media use and procrastination (Hen, 2018; Nauts et al., 2019; Przepiorka et al., 2021). With the evolvement of research aimed at distinct contexts, more details and core contents about procrastination have been elaborated. For example, procrastination in workplace may have association with professional role ambiguity, abusive supervision, workplace ostracism and task characteristics (Hen, 2018; He et al., 2021; Levin and Lipshits-Braziler, 2021). In particular, owing to the use of information and communication technology (ICTs), there currently are ample temptations to distract our attention, and those distractions can exacerbate the severity of procrastination (Du et al., 2019; Hong et al.,

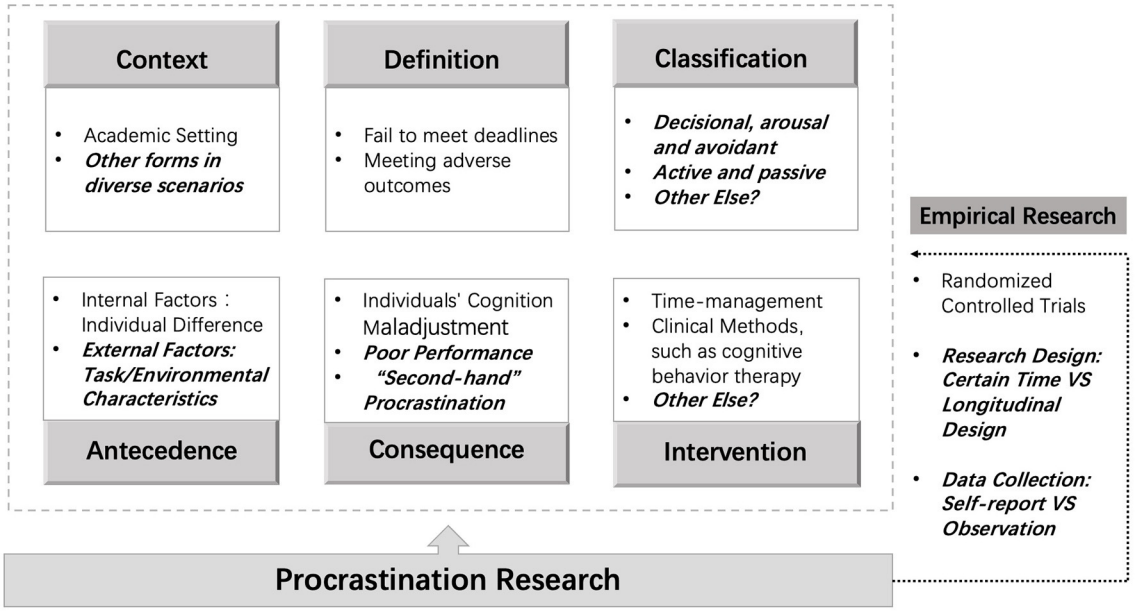

FIGURE 7 | Brief conclusions on procrastination research.

2021). Therefore, how to identify those different forms of procrastination, and then to reduce their adverse outcomes, will be important to discuss.

Second, antecedents and consequences of procrastination are further explored over time. On one hand, how procrastination occurs arises hot discussions from diverse dimensions including time management, personality traits, contextual characteristics, motivational and cognitive factors successively. Interestingly, investigations about neural evidences under procrastination have been emerging, such as the underlying mechanism of hippocampal-striatal and amygdala-insula to procrastination (Zhang et al., 2021). Those antecedents can be divided into internal factors and external factors. Internal factors including character traits and cognitive maladjustments have been elucidated fully, but scant discussion has occurred about how external factors, such as task characteristics, peers' situations, and environmental conditions, influence procrastination (Harris and Sutton, 1983; He et al., 2021). On the other hand, high prevalence of procrastination necessitates the importance to identify the negative consequences including direct and indirect. Prior research paid more attention to direct consequences, such as low performance, poor productivity, stress and illness, but the indirect consequences that can be brought about by procrastination remain to be unclear. For example, "second-hand" procrastination vividly describes the "spillover effect" of procrastination, which is exemplified by another employee often working harder in order to compensate for the lost productivity of a procrastinating coworker (Pychyl and Flett, 2012). Although such phenomena are common, adverse outcomes are less well investigated. Combining the contexts and groups involved, targeted discussions about the external antecedents and indirect consequences of procrastination are expected.

Third, empirical research toward procrastination emphasizes more on validity. When it comes to previous research, longitudinal studies are often of small numbers. However, procrastination is dynamic, so when most studies focus on procrastination of students' sample during just one semester or several weeks, can limit the overall viewpoints about procrastination and the effectiveness of conclusions. With the development of research, more and more longitudinal explorations are springing up to discuss long-term effects of procrastination through behavioral observation studies and so on. Besides, how to design the research and collect data evolves gradually. Self-reported was the dominant method to collect data in prior research, and measurements of procrastination usually depended on different scales. However, self-reported data are often distorted by personal processes and may not reflect the actual situation, even to overestimate the level of procrastination (Kim and Seo, 2015; Goroshit, 2018). Hence, innovative studies start to conduct field experimental designs to get observed information through randomized controlled trials. For the following research, how to combine self-reported data and observed data organically should be investigated and refined.

This bibliometric analysis to procrastination is expected to provide overall perspective for future research. However, certain limitations merit mentioning here. Owing to the limited number of pages allowed, it is difficult to clarify the related articles in detail, so discussion tends to be heuristic. Furthermore, the data for this research comes from the Web of Science database, and applying the same strategy to a different database might have yielded different results. In the future, we will conduct a systematic analysis using diverse databases to detect pivotal articles on procrastination research.

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

BY proposed the research question and conducted the research design. XZ analyzed the data and wrote primary manuscript. On the base of that work mentioned above, two authors discussed and adjusted the final manuscript together.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.809044/full#supplementary-material

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Why Do Students Procrastinate More in Some Courses Than in Others and What Happens Next? Expanding the Multilevel Perspective on Procrastination

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Much is known about the antecedents and outcomes of procrastination when comparing students to one another (i.e., between-person level). However, little is known about the antecedents and outcomes of procrastination when comparing the courses taken by the students during a semester (i.e., within-person level). In this study, we proposed that examining procrastination at both levels of analysis should improve our understanding of the academic experience of students. At both levels, we examined the mediating role of procrastination in the associations between two dimensions of motivation (i.e., autonomous and controlled) and indicators of academic achievement (i.e., grades) and well-being (i.e., positive and negative affect). A sample of 359 university students completed questionnaires measuring their motivation, procrastination, and affect in each of their courses. The official final course grades were obtained at the end of the semester. Multilevel mediation analyses with structural equation modeling were conducted to test our hypotheses. At the between-person level, the indirect effects revealed that higher controlled motivation was significantly associated with worse outcomes (i.e., worse grades and higher negative affect) via higher levels of procrastination. At the within-person level, the indirect effects revealed that lower autonomous motivation was significantly associated with worse outcomes (i.e., worse grades, lower positive affect, and higher negative affect) via higher levels of procrastination. Overall, this study shows that different pathways at each level of analysis may explain how procrastination can be detrimental for the success and well-being of university students.

Keywords: multilevel modeling, well-being, academic achievement, procrastination, motivation

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INTRODUCTION

Learning to manage one's time is an integral part of university life (e.g., Rothschild-Checroune et al., 2012; Hurst et al., 2013; Abdulghani et al., 2014). Academic tasks (e.g., exams, papers, lab reports, and team projects) often have strict deadlines and students need to study or work on these tasks regularly throughout the semester to avoid feeling overwhelmed at the last minute. Some students

struggle to manage their time more than others and thus procrastinate by putting off their academic tasks even though they are aware that their delay will lead to negative consequences (Steel, 2007). The consequences of procrastination are well-documented with meta-analyses showing that it is associated with poorer well-being (van Eerde, 2003; Steel, 2007) and academic achievement (e.g., Richardson et al., 2012; Kim and Seo, 2015). Students who procrastinate more than others thus seem to have more difficulty adjusting to the demands of academic life.

However, students do not behave in the same way across all their courses during a semester. For example, a hypothetical student named Sam might say that they rarely procrastinate in general, but that they frequently procrastinate in their Biology course. Why does Sam procrastinate more in Biology than in their other courses? What are the consequences of Sam's frequent procrastination in Biology? A recently proposed multilevel perspective on procrastination across courses has shown that within-person course procrastination is negatively related to within-person final course grade (Kljajic and Gaudreau, 2018). This means that Sam would be expected to have a lower grade in Biology than in their other courses. As a next step in this new research venue, we propose to expand the nomological network of procrastination by examining its antecedents and outcomes. More precisely, we tested the mediating role of procrastination in the relations between two dimensions of motivation and indicators of achievement and emotional well-being both across students (i.e., between-person level) and across the courses taken by each student during a semester (i.e., within-person level).

Two Dimensions of Motivation, Academic Achievement, and Well-Being

Students have various reasons for being engaged in their academic courses. According to Self-Determination Theory (SDT; Deci and Ryan, 2000; Ryan and Deci, 2020), these reasons can be described as regulatory styles and classified into two dimensions of motivation. The first dimension, called *autonomous motivation*, includes regulatory styles that reflect a deliberate choice to do an activity. Students with high autonomous motivation are engaged in their academic tasks because they are perceived as inherently interesting and enjoyable (i.e., intrinsic regulation), as closely aligned with their foundational values and interests (i.e., integrated regulation), or as personally valuable (i.e., identified regulation). The second dimension of motivation, called *controlled motivation*, includes regulatory styles that reflect internal or external pressure to do an activity. Students with high controlled motivation are engaged in their academic tasks because they want to avoid feelings of shame or guilt due to failure or want to experience better self-esteem due to success (i.e., introjected regulation) or because they want to receive a reward or avoid a punishment (i.e., external regulation). One of the main hypotheses of SDT is that more autonomous regulatory styles should be associated with more engagement, learning, and well-being in the academic domain (Ryan and Deci, 2020). As such, autonomous and controlled motivation are expected to be related differently to outcomes, with autonomous motivation being related to better academic outcomes.

Motivation is often considered as an important ingredient for academic success (Guay et al., 2008). Students who do their academic tasks for autonomous reasons would be most likely to be driven to produce high-quality work and, as a result, achieve very good grades. Several meta-analytical findings have shown that indicators of autonomous motivation (i.e., intrinsic and/or identified regulation) are positively associated with achievement in the academic domain (Richardson et al., 2012; Cerasoli et al., 2014; Taylor et al., 2014; Howard et al., 2021). Likewise, recent studies with university students have generally found that autonomous motivation is significantly and positively correlated to academic achievement (e.g., Bonneville-Roussy et al., 2017; Gareau and Gaudreau, 2017; Yu et al., 2018; Orsini et al., 2019). By contrast, students who do their academic tasks for controlled reasons would most likely do just enough to finish their work without necessarily spending more time on improving its quality. One small-scale meta-analysis with studies using only the Academic Motivation Scale (Vallerand et al., 1992) has shown that indicators of controlled motivation (i.e., introjected and external regulation) are negatively associated with academic achievement (Taylor et al., 2014). However, another broader and more recent meta-analysis has instead found no significant association between indicators of controlled motivation and academic achievement (Howard et al., 2021). Similarly, recent studies with university students have generally found a negative, albeit mostly non-significant correlation between controlled motivation and academic achievement (e.g., Bonneville-Roussy et al., 2017; Jeno et al., 2018; Gareau et al., 2019; Aydin and Michou, 2020). Overall, these findings indicate that autonomous and controlled motivation play a differential role on academic achievement. Although the evidence of the negative role played by controlled motivation is somewhat inconclusive, having more autonomous motivation is clearly a relevant ingredient for greater academic success.

Motivation is also considered as a key variable that can enhance the emotional well-being of students (Ryan and Deci, 2009). Students with high autonomous motivation freely choose to do their academic tasks and, for them, those tasks are perceived as interesting, valuable or personally important. Therefore, such students are more likely to experience better emotional well-being. Meta-analytical findings support this proposition by showing that indicators of autonomous motivation (i.e., intrinsic and identified regulation) are related to higher positive affect and lower negative affect in the academic setting (Howard et al., 2021). Also, when affect is measured in a dispositional/general way or during a medium time-frame (e.g., over a few weeks), autonomous motivation is correlated positively to positive affect and negatively to negative affect (e.g., Litalien et al., 2013, 2015; Waaler et al., 2013; Garn et al., 2019). Conversely, students with high controlled motivation feel an obligation to do academic tasks due to internal or external pressures and, as a result, they are more likely to experience conflicted emotions. A recent meta-analysis showed that indicators of controlled motivation (i.e., introjected and external regulation) are positively related to negative affect; however, conflicting evidence is found for positive affect (Howard et al., 2021). When affect is measured in a dispositional/general way or during a medium time-frame,

negative affect is usually significantly and positively correlated to controlled motivation, whereas the correlation between positive affect and controlled motivation tends to be negative but mostly non-significant (e.g., Litalien et al., 2015; Garn et al., 2019; Sanjuán and Ávila, 2019). Taken together, these results suggest that autonomous motivation is related to better emotional well-being (i.e., higher positive affect and lower negative affect), whereas controlled motivation is related to worse emotional well-being to a certain extent (i.e., higher negative affect).

In order to experience success and well-being, students benefit not only from the right type of motivation, but also from an ability to prioritize the completion of academic tasks over other appealing options (e.g., spending time with friends, watching a movie). When students delay starting or completing an academic task even though they anticipate the negative consequences due to their delay, they are said to be procrastinating (Steel, 2007). Students who procrastinate tend to produce low-quality work and experience more negative affect, such as anger, anxiety, shame, sadness, and dissatisfaction (Patrzek et al., 2012; Grunschel et al., 2013). As shown in **Figure 1**, we propose that procrastination could act as a mediator that can explain how two dimensions of motivation (i.e., autonomous and controlled) relate to academic outcomes (i.e., achievement and affect).

The Mediating Role of Procrastination

Motivation is recognized as playing an important role in the capacity to self-regulate (Molden et al., 2016). On the one hand, students with high autonomous motivation – who perceive their courses as engaging or valuable – would be less likely to constantly and irrationally delay the completion of their academic tasks. Accordingly, studies have found, for the most part, that autonomous motivation is significantly and negatively correlated to procrastination in the academic domain (e.g., Vansteenkiste et al., 2009; Katz et al., 2014; Mouratidis et al., 2018). Indicators of autonomous motivation (i.e., intrinsic and identified regulation) were also mostly negatively correlated to procrastination (Senécal et al., 1995; Lee, 2005; Seo, 2013). On the other hand, students with high controlled motivation – who put pressure on themselves or perceive an external pressure to work on their academic tasks – would be more likely to frequently postpone the completion of their academic tasks to another day. Indeed, most studies in the academic domain have shown a significant and positive correlation between controlled motivation and procrastination (e.g., Vansteenkiste et al., 2009; Mih, 2013; Mouratidis et al., 2018). Furthermore, indicators of controlled motivation (i.e., introjected and/or external regulation) tend to be positively – although not necessarily significantly – correlated to procrastination (Senécal et al., 1995; Lee, 2005; Seo, 2013). Overall, despite the limited number of studies conducted on the two dimensions of motivation and procrastination in the academic setting, the results seem to be fairly consistent: Autonomous and controlled motivation are generally related to less and more procrastination, respectively.

Procrastination is expected to have a negative influence on academic achievement. Many students who procrastinate eventually experience the time pressure to complete an academic task before a deadline and the accumulation of multiple academic tasks to complete at the same time (Patrzek et al., 2012; Grunschel et al., 2013). As a result, these students often do not have enough time to produce high-quality work and get excellent grades. Meta-analytical findings have shown that students who procrastinate more tend to obtain lower grades than students who procrastinate less (van Eerde, 2003; Steel, 2007; Richardson et al., 2012; Kim and Seo, 2015). Even in the courses in which university students procrastinate more than their own average, they tend to obtain lower grades compared to their own average (Kljajic and Gaudreau, 2018). Hence, studies have generally shown that procrastination is negatively related to academic achievement.

Procrastination is also expected to be related to worse emotional well-being. When students procrastinate, they might experience temporary relief by avoiding an academic task that is considered aversive. However, procrastination tends to increase self-generated stress and students often end up feeling worse after they procrastinate (Sirois and Pychyl, 2013). A small-scale meta-analysis with samples of community participants and students revealed that procrastination was significantly negatively associated with positive affect ($r = -0.29$) and significantly positively associated with negative affect ($r = 0.31$; Sirois et al., 2019). Likewise, many studies conducted with university students have shown that procrastination is associated with lower positive affect and greater negative affect (e.g., Turban et al., 2013; Blouin-Hudon and Pychyl, 2015; Balkis and Duru, 2016; Choy and Cheung, 2018; Gautam et al., 2019). Overall, these findings indicate that procrastination is related to worse emotional well-being (i.e., lower positive affect and higher negative affect).

The Present Study

The multilevel perspective proposed by Kljajic and Gaudreau (2018) to measure procrastination and grades across courses was used as a foundation to develop the present study. In their study, Kljajic and Gaudreau (2018) examined the relation between procrastination and grades across students (i.e., between-person level) and across the courses taken by each student during the semester (i.e., within-person level). First, they found that a large percentage of the variance (i.e., 39%) in procrastination and grades was due to the fluctuations across courses (i.e., within-person level), which warranted the usage of a multilevel model. Second, they found a significant and negative association between procrastination and grades at both levels of analysis. However, the results were interpreted differently at each level of analysis. At the between-person level, they found that students who procrastinated *more than others* tended to obtain a lower average grade than others. At the within-person level, they found that in the courses in which students procrastinated *more than their own average*, they tended to obtain a lower final course grade than their own average. Taken together, these results revealed the value of investigating procrastination across the courses taken by university students during a semester.

The present study also measured the relation between procrastination and grades at two levels of analysis. However, we also built upon the study of Kljajic and Gaudreau (2018) in two ways: (a) we proposed two motivational antecedents of procrastination, and (b) we added two indicators of emotional

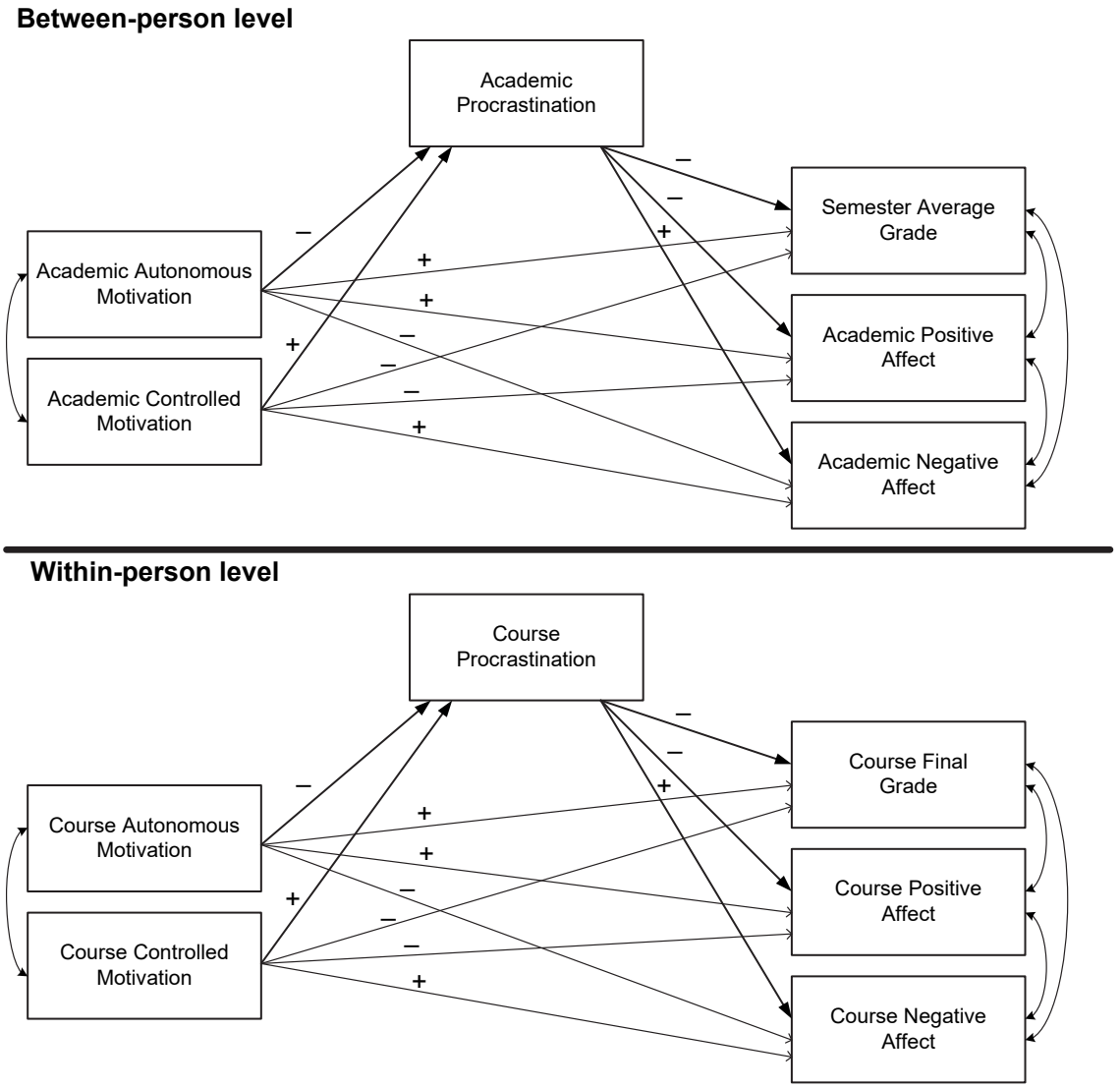

FIGURE 1 | Hypothesized multilevel mediation model.

well-being as outcomes of procrastination. More specifically, we investigated the mediating role of procrastination in explaining how autonomous and controlled motivation relate to three academic outcomes (i.e., grades, positive affect, and negative affect) at the between-person and within-person levels of analysis. We hypothesized that the findings would be comparable at the two levels (see **Figure 1**). However, the results would hold a distinct conceptual meaning at each level.

Between-Person Interpretation (Comparing Students to One Another)

We hypothesized that students with lower autonomous motivation and higher controlled motivation would tend to procrastinate more. In turn, we hypothesized that students who procrastinate more would tend to have a lower average grade and positive affect and a higher negative affect.

Within-Person Interpretation (Comparing Courses to One Another Within Each Student)

In the courses in which students have lower autonomous motivation and higher controlled motivation, we hypothesized that they would tend to procrastinate more. In turn, in the courses in which students procrastinate more, we hypothesized that they would tend to have lower course grades and course positive affect, and higher course negative affect.

MATERIALS AND METHODS

Participants

Participants were recruited in the student pool of the integrated system for participation in research at the University of Ottawa, in Canada. These students were recruited in their first-year

introductory psychology or linguistics courses or in their second-year research methods in communication course. Participants in our study were 359 undergraduate students (71.3% female and 28.7% male). Their age ranged from 16 to 46 years (M = 19.27, SD = 3.24) and they were in their first (68.2%), second (18.1%), third (9.7%), or fourth (3.9%) year of study. Participants were enrolled in health sciences (30.4%), social sciences (29.2%), science (22.6%), arts (7%), engineering (2.8%), management (1.7%), or in multiple faculties (6.1%). They reported that they were taking two (0.8%), three (1.9%), four (22.3%), five (71%), or six (3.9%) courses during the semester. Participants described their ethnic background as European-Canadian/White (46.4%), Asian (22.3%), Arabic (10.9%), African-Canadian/Black (6.1%), Hispanic/Latino (1.7%), Aboriginal/Native (0.6%), or other (12%). They were living with their parents (42.6%), in a residence (29.7%), or in an apartment (27.7%) and they received a full scholarship (3.9%), a partial scholarship (57%), or no scholarship (39.1%) to cover their tuition fees. Some students (41.2%) had to work during the semester and they worked on average 14.86 h per week. This study was approved by the Research Ethics Board of the university.

Procedure

During the fall semester 2019, university students were recruited to participate in a study on their academic experience in each of their courses. The recruitment was conducted online via an integrated system for participation in research. We opened the survey a month after the beginning of the semester to ensure that the participants could reflect on their general experience in each of their courses. All participants completed the consent form for the study. Participants completed demographic and socio-economic questions before they reported how many courses they were taking in the current semester using a drop-down menu including options from one to six courses. Participants were then redirected to the course-related part of the survey that matched their answer on the drop-down menu. For example, if a participant indicated that they had five courses, they were redirected to the webpage "Questions about your five courses" in which they were asked to complete the same questionnaires for each course. For each course, participants were asked to report the course code (e.g., PSY-1101-C) and the name of the professor before they completed questionnaires referring to that course. After the questionnaires for the last course were completed, participants were thanked for their participation in the study and they received one point toward their introductory psychology or linguistics course or their research methods in communication course as compensation.

Measures

Course Autonomous and Controlled Motivation (Independent Variables)

A 10-item questionnaire was used to measure motivation according to SDT (Gareau and Gaudreau, 2017). Participants indicated the extent to which each item corresponded to a reason why they were enrolled in the referred course on a scale from 1 (*not at all for this reason*) to 7 (*totally for this reason*). The items measuring intrinsic regulation (e.g., "Because I truly love it"; two items), integrated regulation (e.g., "It is part of who I am as a person"; two items), and identified regulation (e.g., "In order to pursue goals that are important to me"; two items) were averaged to create a score of autonomous motivation (within-person $\alpha = 0.83$; between-person $\alpha = 0.91$). The items measuring introjected regulation (e.g., "Otherwise, I would feel guilty"; two items) and external regulation (e.g., "Somebody is putting pressure on me"; two items) were averaged to create a score of controlled motivation (within-person $\alpha = 0.74$; between-person $\alpha = 0.94$).

Course Procrastination (Mediating Variable)

A 3-item questionnaire was used to measure procrastination (Kljajic and Gaudreau, 2018) based on items from past questionnaires (Solomon and Rothblum, 1984; Steel, 2010). For each course, participants were presented with a definition of procrastination ("Procrastination refers to when we delay starting or completing some task even though we are aware that negative consequences will probably follow the delay") and were then asked to think about their procrastination on academic tasks (e.g., studying for an exam or writing a term paper) outside of class. They then rated the degree to which they agreed with each item for the referred course on a scale from 1 (*Not at all agree*) to 5 (*Totally agree*). The reliability of this questionnaire was good in this study (within-person $\alpha = 0.84$; between-person $\alpha = 0.93$).

Course Final Grade (Dependent Variable)

For the purposes of this study, participants were given the option to grant access to their official final grades in each of their courses at the end of the semester via the Registrar's Office. A total of 240 participants (67% of the sample) agreed to grant access to their final grades in all their courses. The final grades were based on the official 11-point grading system used by the university: 0 = *F* (0–39%), 1 = *E* (40–49%), 2 = *D* (50–54%), 3 = *D* + (55–59%), 4 = *C* (60–64%), 5 = *C* + (65–69%), 6 = *B* (70–74%), 7 = *B* + (75–79%), 8 = *A* − (80–84%), 9 = *A* (85–89%), and 10 = *A* + (90–100%).

Course Positive and Negative Affect (Dependent Variables)

A 9-item questionnaire was used to measure positive and negative affect (Emmons, 1992). Participants indicated the extent to which they felt a certain way over the past 2 weeks in the referred course on a scale from 1 (*Not at all*) to 7 (*Totally*). Four adjectives measured positive affect (e.g., happy and joyful) and five adjectives measured negative affect (e.g., frustrated and worried/anxious). In this study, the reliability of this questionnaire was excellent for positive affect (within-person $\alpha = 0.94$; between-person $\alpha = 0.95$) and very good for negative affect (within-person $\alpha = 0.88$; between-person $\alpha = 0.91$).

Plan of Analyses

The analyses were conducted in M*plus* version 8 (Muthén and Muthén, 1998-2017). We used Multilevel Structural Equation Modeling (MSEM; see Preacher et al., 2010) to test our hypothesized mediation model at each level of analysis. In

MSEM, the within-person variables are implicitly group-mean centered (Preacher et al., 2010). The full information maximum likelihood (FIML) was used to handle missing data and the robust maximum likelihood estimator (MLR) was used to obtain robust standard errors and chi-square test statistics correcting for non-normality. All paths were treated as fixed effects, because random effects are computationally demanding for such a complex model and would lead to errors in model estimation.[1] Multiple fit indices were used, namely the chi-square (χ^2), CFI, TLI, RMSEA, and SRMR (the last one includes a value at each level of analysis). Nested models were compared with a scaled chi-square difference test (Satorra and Bentler, 2010) using an online calculator[2].

RESULTS

Preliminary Analyses

When we examined our initial sample of 378 university students, we found that 12 participants did not complete any of the relevant questionnaires for this study and we thus removed them for the analyses. We then examined whether the sample included potential outliers. At the within-person level, we calculated the within-person correlations between all the variables of interest for each participant. Each participant could have up to 15 within-person correlations, which were then transformed into *z*-scores. At the between-person level, the average scores of each variable were also transformed into *z*-scores. Participants were considered to be potential outliers at each level of analysis if the two following conditions were met: (a) they had a *z*-score above 3 or below -3 and (b) they were clearly apart from the rest of the sample based on a visual inspection of the distribution. Furthermore, participants could be considered as potential multivariate outliers at the between-person level if their computed score of Mahalanobis distance was higher than the critical value [$\chi^2(6) = 22.46$, $p < 0.001$]. Based on these screening methods, we found no outliers at the within-person level and seven outliers at the between-person level. We conducted the analyses with the outliers ($n = 366$) and without the outliers ($n = 359$) and we found that some parameters changed considerably once the outliers were removed. Therefore, we decided to exclude the seven outliers for the analyses and our final sample included 359 university students.

Descriptive statistics and bivariate correlations can be found in **Table 1**. Of particular interest, we found substantial within-person variability for all the variables in this study (i.e., between 34 and 76%). In other words, all the variables fluctuated considerably across the courses that the students were taking during the semester, which indicated the relevance of using a multilevel framework to test our hypotheses.

We conducted a step-by-step model building approach to determine the model that would provide the best fit to the data while also being the most parsimonious (see **Table 2** for the fit indices of each model). In Model 1, procrastination was assumed to be a full mediator of the relations between the two dimensions of motivation and academic outcomes. None of the direct effects were thus estimated at both levels of analysis. All the fit indices of this first model were poor and unacceptable. In Model 2, procrastination was assumed to be a full mediator at the between-person level, but a partial mediator at the within-person level. That is, all the direct effects were added at the within-person level only. The scaled chi-square difference test revealed that Model 2 provided a better fit to the data compared to Model 1. However, the fit indices of the second model remained unsatisfactory for the most part. All the within-person direct effects were significant and were thus kept in the next model. In Model 3, procrastination was assumed to be a partial mediator at both levels of analysis. In other words, all the direct effects were also added at the between-person level. The scaled chi-square difference test showed that Model 3 provided a better fit than Model 2. However, the third model was fully saturated (i.e., zero degree of freedom). Two between-person direct effects were found to be non-significant, namely the relation between controlled motivation and positive affect and the relation between autonomous motivation and negative affect. These two direct effects were removed in the fourth model. The scaled chi-square difference test indicated that Model 4 did not significantly differ from Model 3. Nevertheless, the fit indices of Model 4 were excellent and this model was more parsimonious than Model 3. Therefore, Model 4 was chosen as the final model.

Main Analyses

The unstandardized parameter estimates of the final model at both levels of analysis are illustrated in **Figure 2**. The total, direct, and indirect effects are shown in **Table 3**.

Between-Person Findings

Autonomous motivation was associated with higher grades and positive affect. By contrast, controlled motivation was associated with lower grades and higher negative affect. Procrastination did not significantly mediate the relations between autonomous motivation and any of the outcomes. However, procrastination was a significant mediator of the relations between controlled motivation and two of the outcomes (i.e., grades and negative affect). Students who experienced more controlled motivation than others were more likely to procrastinate more than others. In turn, students who procrastinated more than their counterparts were more likely to get worse grades and experience more negative affect than their counterparts.

[1]Parameter estimates with fixed vs. random effects were compared using traditional multilevel modeling. The first model examined the relations from the two types of motivation to procrastination. The second model examined the relations from the two types of motivation and procrastination to the three outcomes. All the compared parameter estimates were very similar. Only the association between controlled motivation and grades was noticeably different in a model with fixed effects ($B = -0.248$, 95% CI = −0.469, −0.027, $p = 0.028$) vs. random effects ($B = -0.202$, 95% CI = −0.425, 0.022, $p = 0.077$). Although the statistical significance of this association changes from one model to another, the effect sizes are comparable. Furthermore, the association between controlled motivation and grades is not a central link in our mediation model and we have no evidence that this small change in effect size affects the rest of the model in significant ways. Overall, we believe that these sensitivity analyses suggest that our final results are most likely not affected in important ways by the absence of random effects in our MSEM model.

[2]http://www.thestatisticalmind.com/calculators/SBChiSquareDifferenceTest.htm

TABLE 1 | Descriptive statistics and bivariate correlations at each level of analysis.

	M [a]	*SD* [a]	*SD* [b]	1 – ICC	1	2	3	4	5	6
(1) Autonomous motivation	3.10	0.90	1.06	0.58	–	0.06*	−0.24*	0.11*	0.59*	−0.26*
(2) Controlled motivation	1.59	0.81	0.59	0.34	0.34*	–	0.04	−0.09*	−0.10*	0.16*
(3) Procrastination	2.56	0.86	0.77	0.44	0.02	0.24*	–	−0.24*	−0.34*	0.35*
(4) Grades	6.55	1.86	1.64	0.44	0.08	−0.21*	−0.38*	–	0.30*	−0.36*
(5) Positive affect	3.40	0.74	1.33	0.76	0.60*	0.22*	0.00	0.03	–	−0.52*
(6) Negative affect	2.60	0.77	1.10	0.67	0.26*	0.51*	0.33*	−0.21*	0.26*	–

*$p < 0.05$. Within-person N = 1668 courses. Between-person N = 359 students. Between-person correlations are below the diagonal and within-person correlations are above the diagonal. ICC: intra-class correlation. 1 – ICC: the amount of within-person variance. [a]Between-person level. [b]Within-person level.

TABLE 2 | Fit indices and comparisons of the tested models.

	χ^2	*df*	CFI	TLI	RMSEA	$SRMR_{within}$	$SRMR_{between}$	Contrast	Δdf	$\Delta\chi^2$
Model 1	663.719*	12	0.514	−0.216	0.180	0.123	0.178			
Model 2	139.724*	6	0.900	0.501	0.116	0.009	0.179	1 vs. 2	6	470.846*
Model 3	0	0	1.000	1.000	0.000	0.000	0.000	2 vs. 3	6	139.724*
Model 4	3.255	2	0.999	0.986	0.019	0.002	0.030	3 vs. 4	2	3.255

*$p < 0.05$. Model 1: none of the direct effects was estimated at both levels of analysis. Model 2: direct effects were estimated at the within-person level only. Model 3: direct effects were estimated at both levels of analysis. Model 4: direct effects were estimated at both levels of analysis except for two non-significant direct effects at the between-person level.

Within-Person Findings

Autonomous motivation was associated with marginally higher grades, higher positive affect, and lower negative affect. Conversely, controlled motivation was associated with lower grades, lower positive affect, and higher negative affect. Procrastination did not significantly mediate the relations between controlled motivation and any of the outcomes. However, procrastination was a significant mediator of the relations between autonomous motivation and all the outcomes. In the courses in which students experienced less autonomous motivation than their own average, they were more likely to procrastinate more than their own average. In turn, in the courses in which students procrastinated more than their own average, they were more likely to get worse grades and experience less positive affect and more negative affect than their own average.

DISCUSSION

The current study was designed to take into consideration that procrastination fluctuates not only from one university student to another (i.e., between-person level), but also across the courses that each student is taking during a semester (i.e., within-person level). With the goal of also investigating its nomological network, we proposed that procrastination could mediate the influence of two dimensions of motivation (i.e., autonomous and controlled) on academic achievement (i.e., grades) and well-being (i.e., positive and negative affect) at both levels of analysis. Our main finding was that the antecedent of procrastination differed across levels of analysis. On the one hand, procrastination was negatively associated with *between-person* differences in achievement and well-being because some students experienced more controlled motivation than others. On the other hand, procrastination was negatively associated with *within-person* differences in achievement and well-being because students experienced less autonomous motivation in some courses compared to others. Overall, our results showcase that rich insights can be gained by looking at procrastination and its nomological network through the lens of a multilevel perspective.

Expanding the Multilevel Perspective on Procrastination

The most consistent finding at both levels of analysis was that procrastination was negatively associated with academic achievement and well-being. More precisely, higher procrastination was related to lower grades and more negative affect at both levels, while also being related to less positive affect at the within-person level. These findings are consistent with the recent multilevel study of Kljajic and Gaudreau (2018) which has shown a negative relation between procrastination and grades across students (i.e., between-person level) and across the courses taken by each student (i.e., within-person level). Our results also corroborate meta-analytical findings at the between-person level showing that procrastination relates to lower academic achievement, more psychological maladjustment (van Eerde, 2003; Steel, 2007), and more negative affect (Sirois et al., 2019). Although the outcomes of procrastination are comparable at both levels of analysis, the conceptual meaning and implications of our results differ at each level. If we refer to the fictional example presented in the introduction, Sam – who has a low score of general procrastination – would probably have a better average grade and experience less negative affect than their counterparts who procrastinate more. Yet, because Sam procrastinates more in Biology compared to their other courses, we would expect Sam to have a lower grade and experience less

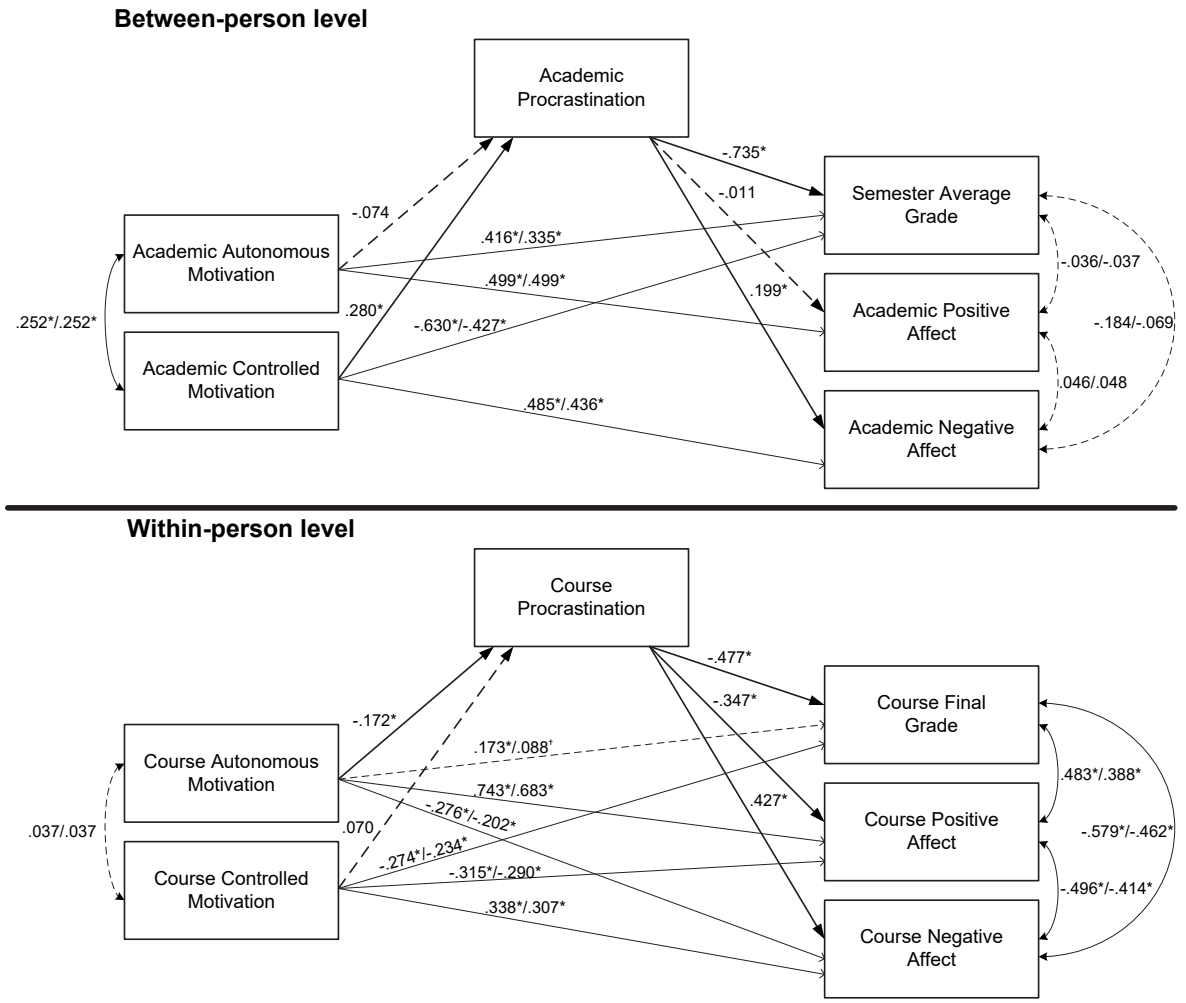

FIGURE 2 | Unstandardized parameter estimates at each level of analysis. $^{*}p < 0.05$, $^{\dagger}p < 0.10$. Full lines represent significant relations; dashed lines represent non-significant or marginally significant relations. The value at the left of the slash is the estimate in the total effect model; the value at the right of the slash is the estimate in the direct effect model.

positive affect and more negative affect in Biology compared to their other courses. Overall, these results highlight that although students like Sam probably do not struggle as much as their counterparts with their procrastination, they are still at risk of experiencing negative outcomes in the courses in which they procrastinate more.

Based on these findings, we might wonder how to help students who struggle with their procrastination in different ways. First, what are some ideas that could potentially help students who – unlike Sam – tend to procrastinate a lot in general? At the between-person level, we found that students with high controlled motivation tend to procrastinate more, which is consistent with results found in past studies (e.g., Vansteenkiste et al., 2009; Mih, 2013; Mouratidis et al., 2018). Thus, if a student procrastinates more than students procrastinate on average, our finding suggests that decreasing controlled motivation (rather than increasing autonomous motivation) would potentially be a good way to reduce their procrastination. It is possible that students who experience high controlled motivation in university feel an external pressure from significant others to be enrolled in a program of study or at an academic institution that is not closely aligned with their own values, interests, and priorities. As such, these students may have enrolled in a program or at an institution that would not have been their personal choice. Furthermore, they may believe that they do not have the required skills to succeed in this program or they might not feel connected to their colleagues in the program. Understanding how basic psychological needs according to SDT (i.e., autonomy, competence, and relatedness; e.g., Ryan and Deci, 2000) are associated with procrastination via controlled motivation could provide some important insights to eventually develop interventions that could help students who generally procrastinate across all of their courses.

Second, what are some ideas that could potentially help students who – like Sam – procrastinate more in some specific

TABLE 3 | Unstandardized estimates and confidence intervals of the total, direct, and indirect effects at each level of analysis.

	Total effect		Direct effect		Indirect effect	
	B	95% CI	*B*	95% CI	*B*	95% CI
Between-person level						
Autonomous motivation to grades	0.416*	[0.057, 0.776]	0.335*	[0.022, 0.649]	0.055	[−0.045, 0.155]
Controlled motivation to grades	−0.630*	[−0.982, −0.279]	−0.427*	[−0.780, −0.074]	−0.206*	[−0.325, −0.086]
Autonomous motivation to positive affect	0.499*	[0.395, 0.602]	0.499*	[0.395, 0.604]	0.001	[−0.008, 0.010]
Controlled motivation to positive affect	0[a]		0[a]		−0.003	[−0.035, 0.029]
Autonomous motivation to negative affect	0[a]		0[a]		−0.015	[−0.042, 0.012]
Controlled motivation to negative affect	0.485*	[0.365, 0.605]	0.436*	[0.310, 0.561]	0.056*	[0.017, 0.094]
Within-person level						
Autonomous motivation to grades	0.173*	[0.077, 0.269]	0.088†	[−0.004, 0.179]	0.082*	[0.049, 0.115]
Controlled motivation to grades	−0.274*	[−0.474, −0.073]	−0.234*	[−0.429, −0.039]	−0.034	[−0.077, 0.010]
Autonomous motivation to positive affect	0.743*	[0.678, 0.807]	0.683*	[0.618, 0.747]	0.060*	[0.037, 0.082]
Controlled motivation to positive affect	−0.315*	[−0.405, −0.225]	−0.290*	[−0.380, −0.199]	−0.024	[−0.055, 0.006]
Autonomous motivation to negative affect	−0.276*	[−0.340, −0.213]	−0.202*	[−0.262, −0.142]	−0.073*	[−0.100, −0.047]
Controlled motivation to negative affect	0.338*	[0.212, 0.465]	0.307*	[0.193, 0.422]	0.030	[−0.009, 0.069]

*$p < 0.05$, †$p < 0.10$. *All indirect effects were tested via procrastination.* [a]*The total/direct effect was fixed at zero.*

courses? At the within-person level, we found that students tend to procrastinate more than their own average in the courses in which they have lower autonomous motivation. Therefore, if a student procrastinates more in a course compared to their own average, our finding suggests that increasing autonomous motivation (rather than decreasing controlled motivation) could be a good way to reduce their procrastination in that course. An avenue that may increase autonomous motivation in the classroom would be for professors to use teaching strategies that support autonomy (Reeve and Jang, 2006), such as giving options to students whenever possible (e.g., evaluation methods, topic of the term paper), explaining why a given academic project that may seem uninteresting is relevant and important for their career, and encouraging an active learning process by creating small discussion groups and asking the students to discuss and summarize a course topic (e.g., Kusurkar et al., 2011). Alternatively, students could perhaps benefit from personal strategies to increase their autonomous motivation outside of the classroom. For example, in a course in which a student has low autonomous motivation, they could write a short paragraph explaining why they believe the topic of a book chapter is relevant to their life or useful for them before they start studying it (e.g., Hulleman et al., 2010; Canning et al., 2018). Such strategies would be especially important in compulsory courses that students are required to take to graduate, compared to elective courses that are selected by choice. All of these strategies could potentially increase the autonomous motivation of a student in a given course. However, we do not know yet whether such strategies could also reduce the procrastination of a student in that course. In future studies, randomized field trials could be designed to assess the extent to which course autonomy-supportive strategies – both inside and outside the classroom – could increase course autonomous motivation and, in turn, reduce course procrastination.

On a final note, we might wonder if students with high levels of average academic procrastination may benefit from focusing on reducing their procrastination in a specific course. In some cases, reducing the general academic procrastination by reducing the controlled motivation of these students may not be a realistic option. For example, if they have already invested a significant amount of resources in their education, some students may feel that they do not have the luxury to change their program or academic institution. Could these students still benefit from attempting to reduce their procrastination in a given course? On the one hand, intervening at such a contextual level may not be enough to reduce the general academic procrastination of a student who already procrastinates a lot in school. On the other hand, having at least one course in which a student experiences more autonomous motivation and less procrastination may spillover to positively influence their experiences in other courses or potentially even encourage the student to decrease their procrastination in general. After all, courses are not completely independent of each other; they coexist within a same timeframe (i.e., academic semester). Our findings offer novel insights to inspire future randomized field trials to determine whether attempting to decrease procrastination in a course can influence other courses or the general academic procrastination of a student.

Limitations and Future Directions

An unexpected finding in this research was that autonomous motivation was not significantly correlated to procrastination at the between-person level ($r = 0.02$). This finding stands apart from a few past studies which have found a moderate negative correlation between autonomous motivation and procrastination ($r = -0.40$ to -0.50; Vansteenkiste et al., 2009; Katz et al., 2014; Mouratidis et al., 2018; for an exception, see Mih, 2013). This difference in the results can potentially be due to the way that the variables have been measured. In past studies, the variables

have been measured with a single questionnaire assessing the general experience of students in a given task such as studying (Vansteenkiste et al., 2009; Study 1, Mouratidis et al., 2018) or doing homework (Katz et al., 2014) or the experience in a given course (Vansteenkiste et al., 2009; Study 2). In our study, motivation and procrastination at the between-person level are instead a combination of the experiences across all courses taken by each student. When students complete a general questionnaire, it is unlikely that they use a mental algorithm to calculate their average experience across all their courses. Instead, their assessment might even be partially biased by a course in which they have a strong positive or negative experience. In future research, we would thus encourage researchers to measure the variables at the between-person level both with a general questionnaire and a summation of experiences across courses to determine whether methodology has a significant influence on the results.

Another finding that would merit further attention is the association between controlled motivation and academic achievement. In our study, we found a significant small-to-moderate negative correlation between these two variables at the between-person level. Although this finding was expected, it does not explain why past empirical evidence on the association between controlled motivation and academic achievement has been inconclusive. To allow us to partially speculate on this topic, we have examined two past studies that have used the same questionnaire of academic motivation and the same measure of objective academic achievement that we used in our study. Both previous studies have shown a non-significant correlation between controlled motivation and academic achievement (Gareau and Gaudreau, 2017; Gareau et al., 2019). One of the possible reasons why our finding differs from the results of these two studies might be because our instructions in the motivation questionnaire are not the same. In our study, participants were asked why they are enrolled in each of their courses whereas, in the two previous studies, participants were asked why they pursue academic activities. When thinking about academic activities in general, students might not only think about their experience in their courses, but also about their general experience on campus (e.g., involvement in student associations, recreational, or competitive sports). Alternatively, they may think only about their courses, but their way of "averaging" their motivation might not be the same as when we compute their motivation score across all their courses. Future research could randomize participants in different groups that use the same motivation questionnaire, but with slightly different instructions, to determine whether this experimental manipulation has an influence on students' responses and ultimately, on the correlation between controlled motivation and academic achievement.

In our study, we proposed that procrastination would influence affect. Accordingly, participants were asked to report their course procrastination in general during the semester and their course affect only during the last 2 weeks. Our reasoning was that participants were likely to think about procrastination episodes that occurred before the assessment of their affect. However, the procrastination episodes could have occurred at the same time and even after their reported affect. For example, an academic task that was perceived as being unclear and uninteresting could have increased the negative affect of a student (e.g., unhappy and frustrated) and, in turn, that student would have been more likely to procrastinate (see Sirois and Pychyl, 2013). Although future studies are needed, untangling the complex bidirectional relations between procrastination and affect may prove to be especially difficult because students experience many fluctuations in procrastination and affect within a short time span (see Pychyl et al., 2000). Nonetheless, our multilevel perspective offers a useful framework to inspire future studies using experience sampling methods. Participants could complete short questionnaires measuring affect and procrastination multiple times during the day (level 1) for several consecutive days (level 2) in the lives of each student (level 3). We could then properly estimate whether previous affect influences subsequent procrastination, whether previous procrastination influences subsequent affect, or both.

We found a noteworthy difference in direction of the correlation between positive and negative affect when comparing the two levels of analysis. At first glance, these findings may seem contradictory. However, this is not a novel finding (e.g., Dunkley et al., 2014; Rush and Hofer, 2014) and previous theories and research have already proposed explanations for this phenomenon (Russell and Carroll, 1999). On the one hand, the correlation is *negative* at the within-person level. In the courses in which students experience more positive affect (e.g., happy and joyful) than their own average, they also tend to experience less negative affect (e.g., frustrated and worried/anxious). We could thus suggest that university students are unlikely to simultaneously experience strong positive and negative affect in the same course within a moderate time frame of 2 weeks. On the other hand, the correlation is *positive* at the between-person level. Students who experience more academic positive affect also tend to experience more academic negative affect than other students. In their broader academic lives (across all of their courses), students are more likely to experience a wider range of affect-inducing events likely to produce both positive and negative emotions (see Folkman and Moskowitz, 2000). Overall, these findings illustrate why a multilevel perspective can be useful to uncover associations likely to differ across levels of analysis.

Most variables in this study were measured at the same time, except for grades which were obtained at the end of the semester. Despite the limitations of a cross-sectional design, this type of design is wise to use as a time-efficient and cost-effective way of answering questions in a new research program (Spector, 2019). In our study, we first needed to establish whether the variables of interest were significantly related – especially at the within-person level – before proposing more complex designs (e.g., longitudinal and experimental). Although we have proposed a theoretically-sound mediational model and we want to encourage researchers to replicate this study, we also recognize that focusing mostly on cross-sectional associations is limitative and does not allow us to infer causality. Future studies could thus come up with more robust designs that could rule out alternative explanations (e.g., adding control variables such as goal setting) or even potentially infer causality. For example, researchers could teach

students some strategies to increase their autonomous motivation and then examine whether in the courses in which students use these strategies more often at the beginning of the semester, they are less likely to procrastinate later in the semester.

One of the main goals of this study was to examine the antecedents and outcomes of procrastination, which is why procrastination is the only mediator in this model. However, given that motivation implies moving *toward* an academic task (Ryan and Deci, 2000) rather than *away* from an academic task like in procrastination, the model could have benefited from adding mediators that imply moving toward an academic task, such as resource management strategies (e.g., time and study environment, effort regulation; see Credé and Phillips, 2011). Therefore, adding other relevant mediators in this multilevel model could be an interesting expansion for future research. Another way to expand the model would be to not only measure personal antecedents (e.g., course motivation), but also contextual antecedents (e.g., course climate and course content) that could influence achievement and well-being via procrastination. Alternatively, researchers could simply examine whether the mediating paths found in this study could also be found with other samples, like high school students or graduate students. By having a better understanding of this multilevel model across various samples, it would be easier to propose and tailor future interventions to reduce procrastination both at a student level and at a course level.

CONCLUSION

In this multilevel study, we found that some students procrastinate more than others (i.e., between-person level) and that students procrastinate more in some courses than in others (i.e., within-person level). In both cases, procrastination was significantly related to lower academic achievement and well-being. However, the antecedents of procrastination were not the same at each level of analysis. This finding suggests that applied psychologists attempting to reduce procrastination would benefit from determining the level at which they want to intervene. If the goal is to reduce the general academic procrastination of a student (compared to other students), it seems preferable to reduce controlled motivation toward school in general. If the goal is to reduce procrastination in a given course (compared to one's own average), it seems preferable to increase autonomous motivation toward that course specifically. Future research will be needed to determine the optimal format and content of potential intervention programs to reduce procrastination at each level. Overall, our study demonstrated that a new understanding of academic procrastination can be gained by examining it from a multilevel perspective.

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 Office of Research Ethics and Integrity, University of Ottawa. The Research Ethics Board of the University of Ottawa determined that minor participants (university students under the age of 18) participating in the integrated system for participation in research were not required to provide a written informed consent from a legal guardian/next of kin to participate in this study. 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. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

KK designed the study, collected the data, conducted the analyses, and wrote the manuscript. BS provided feedback on each version of the manuscript. PG helped with designing the study, conducting the analyses, and providing feedback on the manuscript. All authors contributed to the article and approved the submitted version.

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Past Negative Consequences of Unnecessary Delay as a Marker of Procrastination

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Standard definitions of procrastination underscore the irrational nature of this habit, a critical criterion being that the procrastinating individual delays despite expecting to be worse off for the delay. However, an examination of more than 175 items in 18 procrastination scales reveals that they do not address such a forward-looking criterion. Consequently, scales run the risk of not separating maladaptive and irrational delays from other forms of delay. We propose that forward-looking considerations may not be the best way of operationalizing the irrationality involved in procrastination and argue that scales should instead focus on past negative consequences of unnecessary delay. We suggest a new scale to measure such procrastination-related negative consequences and demonstrate that this scale, used separately or combined with established procrastination scales, performs better in predicting negative states and correlates to procrastination than established scales. The new scale seems to be helpful in separating trivial forms of unnecessary delay from maladaptive forms and hence represents a potentially valuable tool in research and clinical/applied efforts.

Keywords: procrastination, maladaptive delay, irrational delay, procrastination scale, strategic delay

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INTRODUCTION

Behavioral delay is a core characteristic of procrastination. However, as some forms of delay are rational and sensible (e.g., wait until tomorrow to mow your lawn because it is raining today), the delays seen in procrastination are defined as those chosen despite the individual realizing or expecting to be worse off for the delay (Lay, 1986; Steel, 2007; Ferrari, 2010; Klingsieck, 2013). For example, Klingsieck (2013) compared strategic delay and procrastination. Both are characterized by an action being *delayed*, by an action being *intended*, by involving acts that are *necessary or of personal importance*, and by acts being *voluntarily chosen*. In contrast to strategic delay, procrastination is *unnecessary* or *irrational*, is *chosen despite being aware of its potentially negative consequences,* and is *accompanied by discomfort or other negative consequences.*[1] Hence, given subjective norms and cognitive-affective evaluations (Milgram and Naaman, 1996; van Eerde, 2003), procrastinatory behavior is seen as "irrational" or dysfunctional in the sense that the individual chooses to put off against better judgment (e.g., Andreou and White, 2010).

[1]"Discomfort" or "negative consequences" refer to subjective discomfort (e.g., Solomon and Rothblum, 1984; Ferrari, 1998) or other negative consequences (e.g., Simpson and Pychyl, 2009).

Given this understanding of procrastination, one might expect procrastination scales to include items measuring forward-looking considerations of potential negative consequences of putting off. However, they do not. Examination of more than 175 items in 18 scales reveals that only two items address some form of forward-looking cost calculation of negative consequences of procrastination. The first is item 13 from the Tuckman (1991) procrastination scale, "Even though I hate myself if I don't get started, it doesn't get me going." The second is item 17 from the Academic Procrastination State Inventory (APSI; Schouwenburg, 1995), which refers to fear of failure as a reason for putting off. As a result, existing scales run the risk of being indiscriminate in assessing procrastination. For example, if trivial delays are incorrectly perceived as procrastination because of harsh self-judgment (Sirois, 2014; Svartdal and Steel, 2017), procrastination scale scores may be inflated. As existing procrastination scales are the tools used to assess the relation of procrastination to negative states and outcomes (e.g., stress, anxiety, lack of energy, depression, reduced self-efficacy, and well-being; for reviews and meta-analyses, see van Eerde, 2003; Steel, 2007; Klingsieck, 2013) as well as prevalence estimates (e.g., Ferrari et al., 2005), care should be taken to assess the quality of such scales. Hence, scale items assessing the maladaptive and irrational aspects of procrastination are of great scientific and practical interest.

Forward-Looking Considerations of Negative Consequences

Given the importance of the "expecting to be worse off" and "act against better judgment" criteria for identifying the maladaptive and irrational side of procrastinatory behavior, a simple solution might be to include items that reflect consideration of future disadvantages associated with putting off. However, we argue that this solution may not be viable because (1) the subjective availability of future negative consequences of putting off is questionable, (2) studies of subjective reasons for procrastination do not support the existence of forward-looking cost considerations, and (3) known mechanisms in procrastination do not appear to involve future cost considerations.

Subjective Availability and Consideration of Future Negative Consequences

First, one may ask what kind of negative consequences people might have in mind when deciding to put off. Although reviews and meta-analyses have amply documented detrimental correlates to, or consequences of, procrastination (van Eerde, 2003; Steel, 2007), it is unclear whether such correlates or consequences are subjectively available to procrastinators when choosing to delay unnecessarily. For example, procrastination is related to increased stress (Tice and Baumeister, 1997; Sirois, 2014), which is understandable as delayed work with deadlines must be completed in a shorter time. Hence, increased stress might be a subjectively anticipated consequence speaking against putting off tasks. However, we are not aware of research documenting procrastinators to opt to delay despite expecting increased stress. To our knowledge, a similar conclusion applies to many, maybe most, of the observed correlations between procrastination and adverse states and outcomes. For example, although research has documented a reliable and moderately negative relation between academic performance and procrastination (see Kim and Seo, 2015, for meta-analysis), it is not apparent that an individual chooses to procrastinate despite expecting to obtain lower grades. Similarly, research has demonstrated a correlation between procrastination and depression and anxiety (Ferrari et al., 1995; Stöber and Joormann, 2001), but it is not known (or even likely) that the individual has increased depression or anxiety in mind when deciding to procrastinate.

Studies that have examined subjective reasons for putting off planned work (e.g., Schraw et al., 2007) provide little evidence to support forward-looking considerations of negative consequences as part of the decision to put off. For example, one candidate might be *fear of failure* – putting off work on a task because of a lack of perceived competence to complete the task successfully (e.g., Milgram et al., 1988). Although fear of failure may lead to delayed task execution, the opposite has also been reported, as fear of failure may inspire increased motivation and makes one start earlier and work harder (Schraw et al., 2007, p. 19). Conceptually, fear of failure does not create delays "despite expecting to be worse off" either. On the contrary, fear of failure may create delays to protect the individual from doing things with a high probability of failing, which may be a rational decision seen from the actor's perspective when choosing to delay. It is not surprising, therefore, that the correlation between procrastination and fear of failure is low, $r = 0.18$ (Steel, 2007). Other studies (e.g., Lindblom-Ylänne et al., 2015) have identified forward-looking considerations in strategic delay, which (by definition) is not procrastination. Grunschel et al. (2013) had students rate their reasons for academic delay using 14 items, two of which addressed future considerations, but in a *positive* and strategic sense ("Belief that one works better under high pressure" and "Anticipation of a better opportunity").

Mechanisms in Procrastination Are Not Likely to Involve Future Cost Considerations

Given the nature of procrastinatory behavior as impulsive and maladaptive deviations from plans with limited future temporal orientation (Specter and Ferrari, 2000; Díaz-Morales and Ferrari, 2015; Sirois and Pychyl, 2018), it is likely that procrastinatory behavior often may result without much consideration of potential negative consequences. First, procrastinators may, through rationalization and wishful thinking, perceive their procrastinatory behavior as rational. Thus, "irrational" decisions to put off may subjectively appear as rational when decisions are made (e.g., Sigall et al., 2000; Tuckman, 2005). In these cases, individuals put off with no or little concern for future negative consequences. Second, future episodic thinking is negatively related to procrastination (Rebetez et al., 2016), indicating that procrastinators are less likely than others to consider future negative consequences when deciding to put off. Third, as potential negative consequences of putting off may be temporally distant, they tend to have little weight in cost-benefit considerations for action here and now (e.g., Temporal Motivation Theory, TMT;

Steel and König, 2006; Gröpel and Steel, 2008). This is the case particularly for procrastinators, who are impulsive and present-oriented (e.g., Sirois and Pychyl, 2013). Fourth, the fact that decisions to put off are made intuitively, embedded in the flow of action and in the presence of temptations and distractions (e.g., Steel et al., 2018) pinpoints procrastination as a breakdown in self-regulation (Steel, 2007) rather than an outcome of a cost-benefit analysis. Fifth, as putting off is likely when working with aversive and boring tasks, emotional regulation – "giving in to feel good" – is a well-documented mechanism. This mechanism gains importance as individuals get tired, are low in energy, or are stressed (Tice and Baumeister, 1997; Sirois and Giguère, 2018), all suboptimal states to make decisions.

In conclusion, forward-looking considerations of future negative consequences of procrastinatory behaviors seem to be highly problematic in identifying the maladaptive nature of procrastination. The criterion is definitional but not sufficiently supported by theory or empirical studies.

Past Negative Consequences of Procrastination as a Criterion of Maladaptive Delay

If forward-looking considerations of negative consequences of delayed actions are problematic in identifying the maladaptive nature of procrastinatory behavior, then what? In this paper, we propose an alternative view, one that emphasizes subjectively experienced past negative consequences of unnecessary delay as an important marker of the maladaptive and irrational side of procrastination. We suggest a new scale to measure such procrastination-related past negative consequences and argue that this scale, used separately or combined with established procrastination scales, may be superior to existing scales in identifying the problematic and maladaptive aspects of procrastination. Except for the Procrastination Assessment Scale for Students (PASS; Solomon and Rothblum, 1984), self-report procrastination scales do not include items to assess discomfort or negative feelings associated with procrastinatory episodes. Clearly, a scale that differentiates maladaptive and trivial forms of unnecessary delay is of great interest, both in research and in applied/clinical settings.

Theoretical and Empirical Basis

As noted, the forward-looking criterion for procrastination ("...delay despite expecting to be worse off for the delay") is definitional, with minimal explicit theoretical or empirical foundation. Turning this criterion to past negative consequences of unnecessary delay, the definition is kept unchanged, except that the "worse off"-criterion points to past experience rather than future expectations. Empirically, a retrospective criterion is indeed meaningful, as discomfort or and subjective negative feelings associated with procrastinatory behavior have been pointed out by multiple authors in the field (e.g., Ellis and Knaus, 1977; Solomon and Rothblum, 1984; Ferrari, 1998; Simpson and Pychyl, 2009; Klingsieck, 2013). Furthermore, a retrospective criterion with a focus on the discomfort and negative feelings associated with unnecessary delay is consistent with a self-regulation perspective on procrastination (e.g., Tice and Bratslavsky, 2000). Procrastination is assumed to be a breakdown in self-regulation (Steel, 2007), and attempts to exercise self-control is associated with negative emotions, as is failure to self-regulate itself (Tice and Bratslavsky, 2000; Tice et al., 2001; Sirois and Pychyl, 2013). Thus, unnecessary delays related to self-regulation failure should be characterized by discomfort and subjective negative feelings (Krause and Freund, 2014). When such self-regulation failures become vivid to the person in the sense that they are pointed out by others, accompanied by loss, or in other ways demonstrate that one is worse off because of the delay, we find it likely that they are perceived and remembered in a better way compared to delays that have no specific consequences. Hence, negative consequences associated with procrastination have an important discriminative function that helps distinguish it from other forms of delay (e.g., strategic delay, rational forms of delay) and even from procrastination with no specific negative consequences. For example, Lindblom-Ylänne et al. (2015) noted that a subgroup of procrastinators in their study did not demonstrate any subjective discomfort associated with their unnecessary delay, indicating that subjective discomfort and negative feelings associated with procrastination may be an indicator of maladaptive forms.

Importantly, some negative consequences are embedded in short-term positive consequences. Procrastination is regarded as a self-regulation failure with short-term mood repair and emotion regulation as important ingredients (e.g., Tice and Bratslavsky, 2000; Sirois and Pychyl, 2013; Bytamar et al., 2020). Short-term mood repair and emotion regulation imply that negative emotions and cognitions are important antecedents for procrastinatory episodes and that procrastination works to alleviate these negative emotions/thoughts. This view may appear as exactly the opposite of the view discussed in the present paper (i.e., that procrastination is followed by negative consequences). However, it must be remembered that mood repair and emotional regulation both indicate a self-regulation failure. Thus, the immediate positive effect brought about by mood repair is positive only for a limited time, and it is likely that the individual, even at the moment of putting off, or later, experiences discomfort or other negative consequences (see Sirois and Pychyl, 2013, p. 117). A scale focusing on the negative consequences of procrastination must keep this positive-negative duality of procrastinatory episodes in mind.

Immediate Negative Consequences

Discomfort and negative consequences of procrastination may be immediate and delayed, and both forms should be available for self-report. *Immediate negative consequences* of procrastination (e.g., social sanctions from others; realization that the delay was unwise) must be assumed to be more vivid compared to forms of procrastination that do not evoke any specific consequences (e.g., skip working on a difficult assignment with no immediate consequence). Importantly, research has documented that subjective vividness enhances memory (e.g., Kensinger, 2007). Hence, self-report of procrastinatory behaviors associated with negative emotions (i.e., the scale suggested in

this paper) should be more accurate compared to self-report of procrastination in general (i.e., a standard procrastination scale).

Delayed Negative Consequences

A retrospective focus opens for a broader understanding of "negative consequences." Some negative consequences may become apparent only in a retrospective evaluation. For example, after putting off important work, you may realize the next day (or even later) that the delay was unfortunate and hence feel regret and formulate negative cognitions (e.g., Stainton et al., 2000). In their classic study, Tice and Baumeister (1997) demonstrated that the early parts of the semester appear as stress-free and pleasant for procrastinating students, as putting off academic work has no or minimal immediate negative consequences. However, the benefits of procrastination early in the semester had negative consequences later when the student had to work harder to catch up, with more stress and illness as predictable consequences. This indicates that a scale intended to measure negative consequences of procrastination must address a sufficiently long-time span.

For both immediate and delayed negative consequences, an obvious advantage of retrospective analysis is that such an analysis may probe the negative consequences of procrastination over various domains and situations. A scale probing negative consequences of procrastination should assess consequences across several domains/situations in terms of frequency (in which domains/situations are negative consequences most often reported?) as well as relative importance (in which domains/situations do negative consequences affect the individual the most)? If negative consequences of procrastination address the problematic core features of procrastination, such information is of prime importance.

Prior Research on Past Negative Consequences of Procrastination

Whereas prior research has examined reasons for why people procrastinate (e.g., Solomon and Rothblum, 1984), little research has focused on the specific subjective negative consequences associated with procrastination (see Day et al., 2000, p. 127, for an exception). This is surprising, as procrastination research has provided ample evidence of an association between procrastination and adverse states and consequences associated with this habit (van Eerde, 2003; Steel, 2007; Sirois and Kitner, 2015). However, the fact that procrastination subjectively may be positive in the short-term perspective but harmful in the long run, pinpointing the consequences of unnecessary delay may sometimes be complex and possible only in a longer retrospective time frame. Another factor explaining the relative lack of research on subjectively perceived negative consequences of procrastination is the interplay between subjective values and criteria for unnecessary delay. For example, Grund and Fries (2018) demonstrated that high procrastinators tend to be low in achievement values and high in values related to well-being (Study 1), and that people favoring conservative values are more likely to perceive academic procrastination as a failure, whereas individuals endorsing liberal values were more likely to consider situational factors of procrastination (Study 3). Therefore, subjective values may blur the distinction between maladaptive and acceptable forms of delay.

We identified three areas of research that relate directly to negative consequences of procrastination and subsequent procrastination-relevant thinking and behavior. First, in counterfactual thinking (e.g., Roese, 1997), the individual cognitively simulates alternatives to factual states of affairs. Such simulations may compare factual outcomes to better alternatives (upward counterfactuals, e.g., "if I had worked harder, I would have passed with a better grade" when receiving a disappointing grade) or to worse alternatives (downward counterfactuals, e.g., "at least I did not fail the exam" when receiving the disappointing grade). Whereas downward counterfactuals may act as a strategy to repair disappointment and protect the self with little motivation to change, upward counterfactuals generate thoughts about alternative ways of action and may therefore inspire change in the future. Not surprisingly, Sirois (2004) found support for procrastination to be linked to downward counterfactuals, with an immediate positive effect of protecting self-image at the cost of not exploring possible change in the future. Second, research on self-forgiveness in procrastination relates directly to the negative consequences of procrastination and demonstrates how the cognitive processing of such experiences may positively or negatively affect the individual. For example, Wohl et al. (2010) showed that self-forgiveness, the reduction in negative affect associated with procrastination, is positive in the sense that it reduces future procrastination. Similarly, Sirois (2014) found that procrastination is associated with lower levels of self-compassion and that lower levels of self-compassion at least in part explained the procrastination–stress relationship. Third, research addressing cognitions related to procrastination may also be relevant for the present research. Stainton et al. (2000) developed a scale, the Procrastination Cognitions Inventory (PCI), that contains a variety of statements related to own procrastination (e.g., item 1 "Why can't I do what I should be doing?" and item 2 "I need to start earlier"). Importantly, Stainton et al. (2000, Study 2) administered this scale to measure past thoughts (last 3 weeks) as well as future thoughts (future 3 weeks) related to procrastination and found both to correlate moderately with trait procrastination, $r = 0.54$ and 0.48. In effect, these results[2], as well as a subsequent study by Flett et al. (2012), indicate that negative cognitions about past procrastination are related to increased rumination, worry, distress, and stress.

Unfortunately, none of these contributions are reflected in general or academic procrastination scales. However, they support the present work in the sense that some negative consequences of past procrastination may affect future procrastination differently, depending on how they are handled (e.g., downward counterfactual thoughts; self-forgiveness). Others (e.g., negative thoughts related to procrastination) may act in a more direct way to foster future procrastination by increasing negative cognitions and emotions. Clearly, such

[2]Note that future thought as used in the Stainton study were induced by researchers and were not independently generated by participants. Thus, these findings do not contradict our previous argument on subjective availability of future negative consequences.

information is valuable in scale development and interpretation of scale scores.

Scale to Measure Negative Consequences of Procrastination

At present, there is no scale addressing the perceived negative consequences of procrastination. As procrastination-related negative consequences may occur in different domains and situations, the first step in developing such a scale is determining relevant domains/situations. Prior research (e.g., Gröpel and Kuhl, 2006; Ferrari et al., 2009; Klingsieck, 2013; Goroshit et al., 2020) has identified procrastination in several life domains, such as work (including academic work), everyday routines and obligations, health, leisure, family, and partnership, social and financial. Reviews and meta-analyses (e.g., van Eerde, 2003; Steel, 2007) have demonstrated procrastination tendencies ("trait procrastination") to be relatively stable across domains and situations, but it is important to recognize that situational and personality variables may be important in facilitating or hindering actual instances of procrastinatory behavior from occurring (e.g., Wäschle et al., 2014; Steel and Klingsieck, 2016; Svartdal et al., 2020). Hence, we included items to cover procrastination in three different situations/domains that are important and relevant for students and the general population. In addition, we probed more general negative feelings and cognitions associated with procrastinatory episodes[3].

Social

Social aspects of procrastination have received relatively little attention in the procrastination literature (Klingsieck, 2013). However, in several papers, Ferrari and colleagues have documented the role of social factors in procrastination. For example, social comparison is important among students (Ferrari and Patel, 2004), and procrastinators seem to be particularly sensitive to negative social information, probably to protect their self-image (Ferrari, 1991). Research also indicates that social norms and negative emotions associated with transgressing those norms are involved in procrastination (e.g., Giguère et al., 2016). Negative social consequences of procrastination may therefore be markers of problematic delay. Such consequences may appear in many forms, for example, when the procrastinating individual does not meet obligations in interaction with others and is confronted with that fact (e.g., "My friends complain that I delay things unnecessarily").

Performance/Stress

As discussed, research evidence shows a reliable and moderately negative relation between academic performance and procrastination (Kim and Seo, 2015). The mechanisms involved are not clear. However, two classic performance-related negative consequences appear when unnecessary delay renders less time available for task completion and when the delay implies that one gets behind in work (e.g., Steel et al., 2018). Importantly, in both cases, reduced performance may not be apparent to the individual at the time of delay (or even at repeated occurrences of delay) but may become apparent in a retrospective evaluation. Possible scale items to measure this type of negative consequences could be "As a consequence of my tendency to delay things, I am behind in schoolwork" or "Because I delayed work, I must work under time pressure."

Financial

Another set of consequences relates to financial loss or cost due to procrastination. Procrastinators are impulsive, and impulsive decisions and behaviors are associated with problems with personal finances (for an overview, see Gamst-Klaussen et al., 2019). Ferrari et al. (2009) demonstrated that life regret within the financial domain correlated moderately (r = 0.21–0.23) with procrastination score, higher compared to all other domains examined. Financial loss or cost due to procrastination may often be relatively easy to detect and report (e.g., item 15 in the AIP scale, "putting things off till the last minute has cost me money in the past" (Adult Inventory of Procrastination Scale; McCown et al., 1989). Other forms may be more subtle. For example, Reuben et al. (2015) demonstrated that procrastinating students were not only impulsive and preferred a smaller reward now compared to a larger reward 2 weeks later but also slow in cashing in their reward checks. In this case, financial loss may not be directly detectable by the procrastinator, but in retrospect, the maladaptive and irrational nature of such choices may become more visible. Hence, the financial loss/cost dimension was included in the scale.

Negative Emotions

It is well documented that negative emotions are potentially powerful drivers of procrastinatory behavior, as delay may be instrumental in mood repair and avoidance of aversive events (e.g., Blunt and Pychyl, 2000; Wohl et al., 2010; Pollack and Herres, 2020). The emotions of *shame, guilt,* or *regret* address negative feelings related to past events and are of particular interest in the present context. Shame and guilt are associated with transgression of social norms, and both emotions seem to be important in procrastination (Giguère et al., 2016). Lee and Hall (2020) reported a correlation of r = 0.36 between procrastination tendencies and shame, guilt, or regret in undergraduates. These authors also indicated that the negative emotions of guilt, shame, and regret loaded similarly to the latent factor "negative emotions." In the present study, we included an item to address such "retrospective" negative emotions specifically.

Negative Cognitions

As discussed, the Procrastinatory Cognitions Inventory (PCI; Stainton et al., 2000) demonstrates that negative cognitions are positively correlated with procrastination. Several of the items in this scale address disappointment (e.g., item 5, "No matter how much I try, I still put things off"; item 10, "I am letting myself down") and comparative dissatisfaction (item 6, "People want me to work and study more"). Student life offers many arenas where private standards may be challenged, such as exams, comparison to fellow students, and others. In the present studies, two items addressed this issue, one performance-related (working

[3]In the present scale development, the authors and a student group discussed domains/situations and possible scale items.

TABLE 1 | Negative consequences of procrastination in different domains/situations.

	Negative consequences of unnecessary delay
Social	Negative social reactions from others
Loss, cost	Lost opportunities; financial loss; financial cost
Performance, stress	Less time for task completion; stress; get behind in academic work
Negative emotions	Shame, regret, guilt, worry associated with procrastination
Negative cognitions	Expected goals/standards not attained (disappointment)

more slowly than others) and one related to negative thoughts in failed goal attainment due to procrastination (disappointment).

Table 1 summarizes the three situations and domains in which negative consequences of procrastination may appear, as well as negative cognitions and feelings related to procrastinatory episodes. Note that the situations/domains indicated in the table are suggestive and not exhaustive. If the negative consequences of procrastinatory behaviors define the troublesome aspect of this habit, a scale focusing on such consequences is likely to be useful in predicting the negative states and outcomes associated with procrastination. Thus, the scale suggested in this paper, the Negative Consequences of Procrastination (NCP), should be expected to predict known relations between procrastination and positive or negative states and outcomes with better precision compared to standard procrastination scales.

STUDY 1

The main purpose of Study 1 was to explore the utility of a scale, the NCP scale, using items that probe NCP over the situations/domains shown in **Table 1**, in a student sample. The expectation for this scale was that it, despite covering several different situations/domains, still conformed to a unidimensional construct. Moreover, as the NCP is more restrictive compared to standard procrastination scales, the overall mean score of this scale should be lower. The NCP scores should also correlate moderately to highly with a standard procrastination scale, as NCP depend on instances of procrastinatory behavior.

The respondents also answered a standard procrastination scale, the Irrational Procrastination Scale (IPS; Steel, 2010), as well as scales addressing well-being, lack of energy (LoE), and social loafing. Well-being was measured by the Satisfaction With Life Scale (SWLS) (Diener et al., 1985). Several studies have reported a negative relationship between well-being and procrastination (e.g., Sirois et al., 2003; Sirois, 2007; Beutel et al., 2016; Svartdal et al., 2016). In the present study, we expected a similar finding, but we expected that the NCP scale would be superior to the IPS in predicting subjective well-being.

As for LoE, Gröpel and Steel (2008) reported a strong correlation, $r = 0.60$, between procrastination and energy level in a large sample of 9,351 participants, a finding later repeated by Steel et al. (2018) in a student sample. Although the directional relationship between these constructs is not determined, LoE may both act as an antecedent factor in procrastination and as a consequence. For example, low energy increases the likelihood that work becomes aversive, and as task aversiveness is a strong predictor of procrastination (e.g., Blunt and Pychyl, 2000; Grunschel et al., 2013; Laybourn et al., 2019), procrastination may result. However, working with difficult tasks (e.g., academic tasks) may itself be more energy-demanding compared to working with simpler tasks, speaking for a reversal of the causal chain. In both cases, LoE should be associated with negative affect (e.g., Maslach and Jackson, 1984). Therefore, as the NCP scale addresses negative associated with procrastinatory episodes, we expected that the NCP scale would outperform the IPS in predicting LoE.

Well-being and LoE address general phenomena that must be expected to manifest themselves over various situations/domains. In contrast, social loafing is a phenomenon related to the social domain specifically. Despite being a thoroughly studied phenomenon (see Karau and Williams, 1993), the relationship between social loafing and procrastination is not much explored. Ferrari and Pychyl (2012) pointed out that social loafing and procrastination share similarities. For example, both constructs imply reduced motivation to engage in goal-directed task activities and reduced commitment to oneself (procrastination) or to others (social loafing). A difference is that procrastination is seen as an individual problem, whereas social loafing is observed in groups where loafer transgresses social norms and negatively affects group work (e.g., George, 1996). Given the similarities between these phenomena, a moderate correlation between perceived social loafing and procrastination, $r = 0.30$–0.45, was reported (Ferrari and Pychyl, 2012). In the present study, we assessed self-rated social loafing, expecting a similar relation to procrastination. As both procrastination and social loafing are maladaptive, and transgressing social norms is associated with negative emotions (Giguère et al., 2016), we expected that a scale that focuses explicitly on the maladaptive and negative aspects of procrastination – the NCP – will be superior in predicting social loafing.

Method

Participants

Students (201 in total, 137 females), mean age = 24.3 years ($SD = 4.29$) participated. All were recruited by mail and social media invitations among students at a Norwegian University.

Material

Irrational Procrastination Scale (IPS)

This IPS (Steel, 2010) is a nine-item scale focusing on implemental delay (e.g., Item 7 "I delay tasks beyond what is reasonable"). It conforms to a unidimensional construct and demonstrates high internal consistency. In the present study, a translated and reduced six-item scale was used (Svartdal, 2017; Svartdal and Steel, 2017). Higher scores indicate increased procrastination. Internal reliability in the present sample was excellent, $\alpha = 0.93$.

Negative Consequences of Procrastination (Custom)

As discussed, this scale aims to identify past NCP over different domains/situations. The scale should be administered immediately after a standard scale measuring procrastination to ensure that "procrastination" is understood in the same

way across respondents. The format is open, with negative consequences indicated as examples. In the selection of examples, we explored potential examples from published literature, existing scale items, and face-valid examples. The actual examples selected were deemed to reflect possible NCP as perceived by students. Thus, this scale asks respondents to think back on situations in which planned and/or important tasks were delayed unnecessarily – "you procrastinated." Then they were asked, with such situations in mind, to indicate (1–5, 1 = "does not fit at all" and 5 = "fits very well") the appropriateness of eight assertions, with examples mentioned in parentheses. For example, item 1 addressed the social domain (negative reactions from others, e.g., that friends or acquaintances comment that I delay things unnecessarily), and item 3 addressed missed opportunities (e.g., that I did not respect an important deadline). For some domains/situations, two items were formulated. The full list of items and examples are listed in **Appendix**. We also included two additional items, one addressing stress ("The fact that I procrastinate gives me more stress") and one addressing financial loss ("Putting things off till the last minute has cost me money in the past" (AIP item 15; McCown et al., 1989). These items were expected to overlap closely with NCP items 4 and 5.

Satisfaction With Life Scale (SWLS)

The five-item SWLS (Diener et al., 1985) measured life satisfaction. This scale aims to capture subjective global life satisfaction (e.g., item 3, "I am satisfied with my life"). Internal consistency in the present sample was $\alpha = 0.87$.

Lack of Energy

Overall LoE was measured by a shortened version of the Chalder et al. (1993) LoE scale. This reduced version confirms to a single factor with good psychometric properties (DeArmond et al., 2014). Whereas the original scale asks respondents to rate LoE during the last 7 days, we reformulated the time span to "the last weeks." An example item is ". . .how frequently have you felt physically exhausted." Prior research in our group (unpublished) indicated that item 5 (". . . had little or no desire to do anything") produced a lower factor loading. This item was therefore not included in the present study. Internal consistency in the present sample was $\alpha = 0.90$.

Social Loafing Tendencies

Self-reported social loafing was measured by five items from the Social Loafing Tendencies scale (Schippers, 2014). Sample items include "I prefer to let the other team members to do the work if possible" and "I contribute less than I should." Internal consistency was good, $\alpha = 0.83$.

Procedure and Ethics

All items were answered in a web-based survey (Qualtrics.com). Before answering, participants were briefly informed about the purpose of the study and actively consented to participate by pressing a button on the screen. The current study is part of a larger project that received ethical approval from the Regional Ethical Board in Tromsø, Norway (REK Nord 2014/2313) and the Ethical board of our university (December 2020). Participants were informed that they could participate in a lottery for a gift card by providing their phone number. This information was deleted prior to analysis.

Statistical Analysis

Exploratory factor analysis of the NCP scale was performed using the principal axis method. Prior to analysis, assumptions were tested by Bartlett's test for sphericity and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy. For these tests, as well as for computation of internal reliability in the scales used, we used Statistica 14.0.

Ordinary least squares (OLS) regression (robust standard errors) was used to assess the IPS and NCP in predicting the outcome variables. In these analyses, the IPS and NCP were first assessed separately for each outcome variable. In the second step, we examined the unique contribution of NCP in the explanation of dependent variables. However, as the NCP does not contain information on the level of procrastination, in the final step, we tested an adjusted NCP (i.e., NCP corrected for the individual's level of procrastination). These analyses were performed in Stata 17.0.

Results

Initial analyses indicated that age was not involved in any main or interactive effects. As for gender, men demonstrated significantly higher scores in the SWLS scores ($M = 3.55$ vs. 3.27, $p = 0.02$) and in the Social Loafing scores ($M = 1.79$ vs. 1.61, $p = 0.04$), whereas the LoE measure was significantly higher in women ($M = 3.17$ vs. 2.62, $p < 0.001$). However, no significant interaction effects were observed. Hence, the age and sex factors were not included in the analyses reported here.

Negative Consequences of Procrastination Scale

Basic Properties

Internal reliability (eight items) was good, $\alpha = 0.86$. As this scale addresses negative consequences following procrastination, it should correlate moderately to highly with the IPS, and it did, $r = 0.44$ (see **Table 2**). As expected, the mean score of the NCP was lower compared to the IPS mean score, IPS mean = 2.99 vs. NCP mean 2.57 (**Table 2**).

In the next step, we examined the occurrence of procrastination-related negative consequences over the different situations/domains probed. As is indicated in **Figure 1**, four indicators demonstrated higher scores compared to the others: Slow working pace compared to others, time pressure/getting behind, negative feelings, and disappointment of self. Further, as is apparent from the figure, the AIP 15 item corresponded well to the NCP item "Financial loss," and the NCP item "Time pressure; got behind" corresponded well to the stress item. The correlation between IPS and the negative feelings item in NCP was $r = 0.37$, closely resembling the corresponding correlation reported by Lee and Hall (2020).

Dimensionality

An exploratory factor analysis (EFA) was conducted on the 8 NCP items with principal axis factoring extraction. The KMO measure of sampling adequacy was 0.84, well above the recommended minimum value of 0.5, and the Bartlett test

TABLE 2 | Descriptive statistics and Pearson's correlations for study variables (N = 200).

Variables	Mean (*SD*)	(1)	(2)	(3)	(4)	(5)	(6)
(1) IPS	2.99(0.95)	1.000					
(2) NCP_{all}	2.57(0.76)	0.443*	1.000				
(3) NCP_{red}	2.67(0.84)	0.337*	0.957*	1.000			
(4) NCP_{adj}	2.78(0.74)	0.830*	0.832*	0.795*	1.000		
(5) SWLS	3.34(0.76)	−0.167	−0.328*	−0.313*	−0.299*	1.000	
(6) LoE	3.03(0.93)	0.264*	0.389*	0.383*	0.398*	−0.532*	1.000
(7) S Loaf	1.68(0.64)	0.304*	0.408*	0.337*	0.396*	−0.200	0.029

*NCP_{all}, all NCP items included; NCP_{red}, NCP with items 2, 3, 4, 6, 7; NCP_{adj}, NCP adjusted by IPS; Correlations with *$p < 0.005$.*

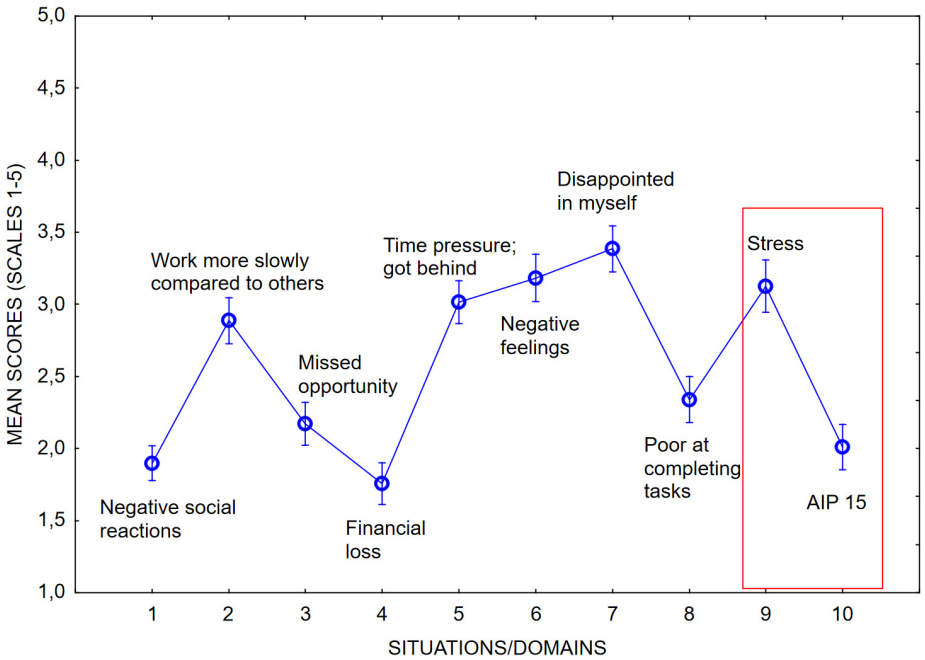

FIGURE 1 | Mean scores of the NCP over different domains.

of sphericity was significant [$\chi 2$ (28) = 732.81, $p < 0.01$] indicating suitability of the sample for factor analysis. The results indicated a unidimensional structure based on Scree plot test and examination of eigenvalues (greater than 1). The factor had eigenvalue of 3.58 and explained 44.7% of the variance. Factor loadings ranged from 0.48 (item 1) to 0.81 (items 6 and 7).

As the NCP was used in comparative analyses with the IPS (see next section), we also performed an EFA on the 8 NCP and 6 IPS items combined. The KMO measure of sampling adequacy was 0.90, and the Bartlett test of sphericity was significant [$\chi 2(92)$ = 1736.12, $p < 0.01$], both indicating suitability of the sample for factor analysis. Results from the initial factor analysis produced two factors based on the Scree plot and eigenvalues greater than 1 (eigenvalues 4.60 and 3.37). However, items 1, 5, and 8 of the NCP demonstrated cross-loadings with the IPS factor and were deleted. A new iteration of EFA without NCP items 1, 5, 8 demonstrated two distinct constructs with no cross-loadings, eigenvalues 4.95 and 1.87. Factor loadings of the reduced NCP ranged from 0.40 (item 4, Financial loss) to 0.85 (item 7, Disappointment). The final structure model accounted for 61.96% of the variance. Internal reliability of this reduced NCP scale was good, $\alpha = 0.82$.

Descriptive Results

Descriptive results are presented in **Table 2**. Of particular interest here is the lower mean score of the NCP (all items) compared to IPS, 2.57 vs. 2.99. This indicates that the overall NCP renders a more conservative estimate of procrastination problems compared to the IPS procrastination score, as expected. Also, note the moderate correlation between IPS and NCP, r = 0.44, indicating that these measures address similar but not identical constructs. Finally, note that the correlations between NCP and the scales measuring well-being, LoE, and social loafing were higher compared to the corresponding correlation to the IPS. As discussed, this probably reflects the fact that NCP addresses the maladaptive sides of procrastinatory episodes explicitly. These correlations also demonstrate predictable convergent as well as divergent validity for the NCP to established measures.

Two other versions of the NCP were computed. First, based on EFA results, we created a reduced NCP, the NCP_{red} (Items 1, 5, and 8 omitted). Note in **Table 2** that the NCP_{red} correlates even lower to the IPS, $r = 0.34$. Second, because NCP does not contain information on procrastination level, a better measure might be suggested. Thus, we constructed an "adjusted" NCP, i.e., the NCP corrected for the individual's level of procrastination. Different solutions were explored. The one reported here was calculated as the square root of the NCP score * IPS score. Hence, this adjusted index gives the same overall weight to the two scales. The resulting index, NCP_{adj}, correlated highly with the IPS, $r = 0.83$, and 0.83 with the overall NCP score.

Regression Analyses

We performed separate regression analyses with social loafing, well-being, and LoE as dependent variables and IPS and NCP_{red} as predictors. The reduced version of NCP (five items, items 1, 5, and 8 excluded) was used. Here we expected that both predictors would explain the dependent variables. However, because the NCP addresses the problematic and maladaptive aspects of procrastination directly, it was expected to explain dependent measures better compared to IPS. The results confirmed these expectations. As is seen in **Table 3**, the NCP_{red} turned out to be a better predictor of all three dependent measures.

Second, we conducted separate hierarchical linear regression analyses to examine the unique contribution of NCP_{red} in the explanation of social loafing, well-being (SWLS), and LoE. Here, it was expected that NCP_{red} would significantly contribute to the explanation of the dependent variables. The results confirmed this expectation (see **Table 4**). IPS alone significantly contributed to the three regression models (i.e., Step 1) and accounted for 9.2, 2.9, and 7.4% of the variation in social loafing, SWLS, and LoE, respectively. Adding NCP_{red} into the model explained an additional 6.2, 7.5, and 10.3% of the variation in social loafing, SWLS, and LoE. This change (and the models with NCP_{red} term) was significant for all three variables. Further, as seen in **Table 4**, NCP_{red} was the most important predictor. In sum, this means that a measure of past NCP, the NCP_{red}, contributes to explaining the dependent variables above the traditional IPS measure.

In the final step, we compared the IPS and NCP_{adj} by conducting linear regression analysis (performed separately for IPS and NCP_{adj}). Since NCP_{red} does not contain information on procrastination level, IPS was compared with an adjusted version of NCP. **Table 5** summarizes the results and shows that NCP_{adj}, compared to IPS, was a better predictor and explained a larger proportion of variation in all dependent measures. These results indicate that the adjusted version was superior to the IPS, which supports our assumption about the importance of the NCP.

In summary, the results supported our hypothesis that negative consequences of procrastination are important in making this form of delay detrimental. As discussed, not every type of delay is necessarily detrimental or procrastination (e.g., Klingsieck, 2013). Since the IPS scale is seemingly addressing both general delay and procrastination, it showed weaker relationships with subjective well-being, LoE, and social loading compared to the NCP_{red} and NCP_{adj}.

TABLE 3 | Regression analysis (Beta/R^2/robust SE) for IPS and NCP_{red} in predicting SWLS, LoE, and social loafing.

	IPS	NCP_{red}
SWLS	–0.135/0.029 /0.062*	–0.282/0.100 /0.068
LoE	0.267/0.074/0.066	0.436/0.157 /0.074
S Loafing	0.204/0.092/0.046	–0.257/0.114 /0.060

*NCP_{red} = items 1, 5, and 8 deleted. All effects = $p < 0.001$ except * < 0.05.*

TABLE 5 | Regression analysis (Beta/robust SE/R^2) for IPS and IPS_{Adj} in predicting SWLS, LoE, and social loafing.

	IPS	NCP_{adj}
SWLS	–0.135/0.062/0.029*	–0.306/0.083/0.092
LoE	0.267/0.066/0.074	0.515/0.081/0.169
S Loafing	0.204/0.046/0.092	0.343/0.064/0.157

*NCP_{adj} = square root of NCP_{red} * IPS. All effects = $p < 0.001$ except * < 0.05.*

TABLE 4 | Hierarchical regression analysis for SWLS, LoE, and social loafing.

Independent variables	SWLS		LoE		Social Loafing	
	β	ΔR^2	β	ΔR^2	β	ΔR^2
Step 1						
IPS	–0.135*	0.029*	267**	0.074**	0.204**	0.092**
Adjusted R^2	0.024		0.070		0.088	
Step 2						
IPS	–0.055		0.151*		0.144*	
NCP_{red}	–0.260**	0.075**	0.377**	0.103**	0.201**	0.062**
R^2	0.104		0.178		0.154	
Adjusted R^2	0.095		0.169		0.146	

SWLS, subjective well-being; LoE, lack of energy; NCP_{red}, reduced version of the NCP.
$\Delta R^2 = R^2$ change. Unstandardized regression coefficients are reported. n = 197.
$^*p < 0.05$; $^{**}p < 0.001$.

STUDY 2

Study 2 was designed as a replication and extension of Study 1 with additional scales. First, we added a second procrastination scale, the implemental part of the Pure Procrastination Scale (PPS; Steel, 2010), as a supplement to the IPS. Second, three other scales supplemented those used in Study 1, the General Self-Efficacy Scale (GSE; Schwarzer and Jerusalem, 1995), a scale measuring negative thoughts and emotions in performance situations, the Achievement Motives Scale (AMS-R, five items covering negative emotions; Lang and Fries, 2006), and a scale assessing depression-like feelings and thoughts, the Behavioral Activation for Depression Scale (BADS-SF, short version; Kanter et al., 2007). Published research indicates that all three scales demonstrate predictable relationships with procrastination. Thus, self-efficacy is negatively related to procrastination, $r = -0.44$ (van Eerde, 2003), whereas procrastination correlates positively to a mastery-avoidance goal orientation (e.g., Howell and Watson, 2007) and to depression (van Eerde, 2003). The SWLS and LoE scales used in Study 1 were retained. Overall, we expected that the established procrastination scales, the IPS and PPS, would demonstrate predictable relationships with the dependent variables but that the NCP, especially the adjusted NCP, would perform better.

Method

Participants

Students (223 in total, 180 females), mean age = 25.55 years (SD = 7.96) participated in the study. All were recruited by mail, social media, and lecture invitations among students at Norwegian universities. The relatively high proportion of females (ca. 80%) is somewhat higher compared to the overall proportion of females in the Norwegian student population (ca. 60%; Statistics Norway, 2021) but still typical of many study topics (e.g., psychology).

Material

Procrastination was measured by the IPS, as in Study 1. Also, the NCP (custom) scale, the SWLS (Diener et al., 1985), and the LoE (Chalder et al., 1993; DeArmond et al., 2014) scales were included, unchanged from Study 1. Detailed description of the scales is provided in Study 1, Methods section.

Pure Procrastination Scale (Steel, 2010), five middle items, were included. These items are all from the GPS (Lay, 1986) and are assumed to address implemental delay, as does the IPS (Svartdal and Steel, 2017). Example items are "In preparation for some deadlines, I often waste time by doing other things (PPS item 4; original GPS item 12) and "I generally delay before starting on work I have to do" (PPS item 8, original GPS 9). Higher PPS scores indicate increased procrastination. Internal reliability in the present sample was excellent, $\alpha = 0.94$.

Achievement Motives Scale (Lang and Fries, 2006) has two subscales, one addressing approach motivation in achievement settings (e.g., "I like situations, in which I can find out how capable I am"), and one addressing avoidance motivation (called "fear of failure," e.g., "If I do not understand a problem immediately I start feeling anxious"). In the present study, we included the five items addressing negative motivation. Lang and Fries (2006) reported good psychometric properties for the AMS-R, with CFA results supporting a two-factor structure in the general population (N = 3523) as well as in smaller student samples. In the present study, internal reliability for the 5-item subscale was good, $\alpha = 0.87$.

Behavioral Activation for Depression Scale (Short Form) (BADS-SF). The BADS-SF is a nine-item questionnaire designed to measure activation and avoidance tendencies associated with depression. It is based on a larger scale (Kanter et al., 2007). In the present study, we used eight items that load on the activation and avoidance subscales of the complete BADS (Kanter et al., 2007), e.g., "I engaged in many different activities" and "Most of what I did was to escape from or avoid something unpleasant." The activation items were reversed so that the BADS-SF score reflected avoidance and less activation. Internal reliability in the present sample was acceptable, $\alpha = 0.73$.

General Self-efficacy Scale (Schwarzer and Jerusalem, 1995) measured general self-efficacy beliefs (e.g., item 1, "I can always manage to solve difficult problems if I try hard enough"). Internal reliability for the GSE (10 items) was good in the present data set, $\alpha = 0.87$.

Statistical Analysis

The statistical approach was identical to that used in Study 1.

Results

Initial analyses indicated that age was not involved in any main or interactive effects. No sex difference was observed in the SWLS scores. Men demonstrated higher GSE scores compared to women (M = 3.54 vs. 3.88, $p < 0.01$), whereas women demonstrated higher scores on the BADS-SF subscale (M = 2.79 vs. 2.46, $p < 0.01$) and on the AMS-R subscale (M = 3.70 vs. 3.05, $p < 0.01$). As in Study 1, the LoE measure was significantly higher in women (M = 3.26 vs. 2.69, $p < 0.01$). However, no significant interaction effects were observed, and the variables (age, sex) were not included in subsequent analyses.

Negative Consequences of Procrastination Scale

Internal reliability in the NCP scale was good, $\alpha = 0.88$. We conducted EFA (principal axis factoring, pomax rotation) with the same factor selection criteria as in Study 1. The results confirmed the results from Study 1, indicating the overall scale to confirm to a unidimensional construct, eigenvalue 3.80, 47% of the total variance accounted for. Adding the IPS and PPS into the exploratory factor analysis, the NCP items 1, 5, and 8 demonstrated cross loadings and were deleted. The remaining indicators conformed to two factors, eigenvalues 8.42 and 1.78, 63.78% of the total variance accounted for. These results repeated the outcomes from Study 1.

Figure 2 displays the mean scores of negative consequences associated over the different situations/domains covered in the NCP. As in Study 1, four indicators demonstrated higher scores compared to the others: Slow working pace compared to others, time pressure/getting behind, negative feelings, and disappointment of self.

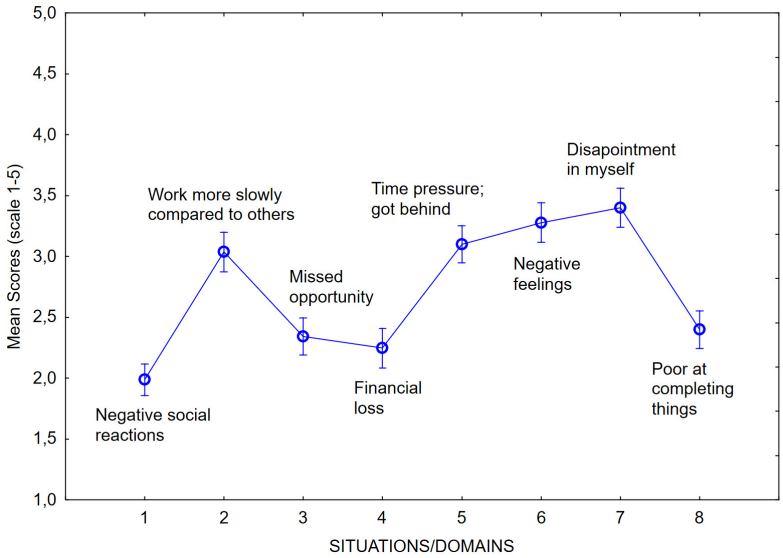

FIGURE 2 | Mean scores of the NCP over different domains/situations.

TABLE 6 | Descriptive statistics and Pearson's correlations for study variables (N = 222).

	M (*SD*)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) IPS	3.07 (0.93)	1.000									
(2) PPS	3.03 (1.13)	0.845	1.000								
(3) NCP_{all}	2.72 (0.86)	0.517	0.521	1.000							
(4) NCP_{red}	2.86 (0.96)	0.449	0.456	0.970	1.000						
(5) NCP_{adj}IPS	2.92 (0.81)	0.839	0.760	0.875	0.856	1.000					
(6) NCP_{adj}PPS	2.89 (0.90)	0.781	0.876	0.845	0.819	0.947	1.000				
(7) SWLS	3.44 (0.72)	−0.329	−0.325	−0.372	−0.373	−0.413	−0.411	1.000			
(8) LoE	3.14 (0.94)	0.316	0.309	0.293	0.324	0.374	0.371	−0.457	1.000		
(9) AMS-R	3.55 (0.97)	*0.218*	0.272	0.441	0.464	0.403	0.413	−0.392	0.486	1.000	
(10) GSE	3.61 (0.58)	−0.220	−0.246	−0.420	−0.393	−0.372	−0.375	0.439	−0.280	−0.503	1.000
(11) BADS	2.72 (0.67)	0.508	0.492	0.504	0.476	0.585	0.582	−0.504	0.571	0.504	−0.503

NCP_{all}, all NCP items included; NCP_{red}, NCP with items 2, 3, 4, 6, 7; NCP_{adj}IPS, NCP adjusted by IPS; NCP_{adj}PPS, NCP adjusted by PPS. All correlations $p < 0.005$.

Descriptive Results

Means and correlations are shown in **Table 6**. Note again that NCP_{all} demonstrated a lower mean compared to the IPS and PPS, as was expected.

Regression Analyses

Table 7 displays the beta values as well as R^2 in predictions of the dependent measures of Study 2. In these analyses, the IPS, PPS, and NCP were entered in separate regression analyses. Note that the NCP_{red} demonstrated similar predictive abilities as the procrastination scales for SWLS, LoE, and BADS-SF, and better for AMS-FF and GSE.

Second, we conducted separate hierarchical linear regression analyses to examine the unique contribution of NCP_{red} in the explanation of well-being (SWLS), LoE, fear of failure (AMS-FF), general self-efficacy (GSE), and depression-related behavioral activation (BADS-FF). Here it was expected that NCP_{red} would significantly contribute to the explanation of the dependent variables. The results confirmed this expectation. The results for IPS are displayed in **Table 8**. IPS alone significantly contributed to the three regression models (i.e., Step 1) and accounted for 10.8, 9.7, 4.6, 4.8, and 6.9% of the variation in SWLS, LoE, AMS-FF, GSE, and BADS-SF, respectively. Adding

TABLE 7 | Regression analysis (Beta/R^2) for IPS and PPS in predicting SWLS, LoE, AMS-FF, GSE, and BADS-SF.

	IPS	PPS	NCP_{red}
SWLS	−0.255/0.108	−0.208/0.106	−0.282/0.139
LoE	0.317/0.097	0.245/0.087	0.315/0.101
AMS-FF	0.225/0.046	0.224/0.068	0.468/0.210
GSE	−0.137/0.048	−0.125/0.060	−0.238/0.154
BADS-SF	0.365/0.256	0.287/0.234	0.333/0.224

NCP_{red} = NCP with items 2, 3, 4, 6, 7.

TABLE 8 | Hierarchical regression analysis for SWLS, LoE, AMS-FF, GSE, and BADS-SF.

Independent variables	SWLS	LoE	AMS-FF	GSE	BADS-SF
	β	β	β	β	β
Step 1					
IPS	−0.255**	0.317**	0.225*	−0.137*	0.365**
Adjusted R^2	0.104	0.093	0.042	0.044	0.253
ΔR^2	0.108**	0.097**	0.046*	0.048*	0.256**
Step 2					
IPS	−0.157*	0.215*	0.013	−0.034	0.266**
NCP_{red}	−0.213**	0.220*	0.462**	−0.223**	0.217**
R^2	0.172	0.137	0.210	0.156	0.332
Adjusted R^2	0.164	0.129	0.202	0.149	0.326
ΔR^2	0.064**	0.039**	0.163**	0.108**	0.078**

SWLS, subjective well-being; LoE, lack of energy; AMS-FF, achievement motivation scale – fear of failure; GSE, general self-efficacy; BADS-SF, behavioral activation for depression scale – short form; NCP_{red}, reduced version of NCP.
$\Delta R^2 = R^2$ change. Unstandardized regression coefficients are reported. n = 223.
$^*p < 0.05$; $^{**}p < 0.001$.

TABLE 9 | Hierarchical regression analysis for SWLS, LoE, AMS-FF, GSE, and BADS-SF.

Independent variables	SWLS	LoE	AMS-FF	GSE	BADS-SF
	β	β	β	β	β
Step 1					
PPS	−0.208**	0.245**	0.224**	−0.125*	0.287**
Adjusted R^2	0.102	0.083	0.063	0.055	0.231
ΔR^2	0.106**	0.087**	0.068**	0.060**	0.234**
Step 2					
PPS	−0.125*	0.157*	0.055	−0.042	0.201**
NCP_{red}	−0.215**	0.229*	0.438**	−0.215**	0.224**
R^2	0.169	0.129	0.213	0.159	0.315
Adjusted R^2	0.162	0.121	0.201	0.151	0.308
ΔR^2	0.064**	0.042*	0.145**	0.100**	0.080**

SWLS, subjective well-being; LoE, lack of energy; AMS-FF, achievement motivation scale – fear of failure; GSE, general self-efficacy; BADS-SF, behavioral activation for depression scale – short form; NCP_{red}, reduced version of NCP.
$\Delta R^2 = R^2$ change. Unstandardized regression coefficients are reported. n = 223.
$^*p < 0.05$; $^{**}p < 0.001$.

TABLE 10 | Regression analysis (Beta/robust SE/R^2) for IPS and IPS_{Adj} in predicting SWLS, LoE, GSE, and BADS-SF.

	IPS	NCP_{adjIPS}	PPS	NCP_{adjPPS}
SWLS	–0.255/0.052/0.108	–0.366/0.053/0.171	–0.208/0.042/0.106	–0.329/0.049/0.169
LoE	0.317/0.068/0.097	0.428/0.072/0.136	0.245/0.062/0.087	0.375/0.071/0.129
AMS-FF	0.225/0.074/0.046*	0.477/0.072/0.158	0.224/0.060/0.68	0.434/0.067/0.162
GSE	–0.137/0.041/0.048	–0.265/0.041/0.138	–0.125/0.032/0.060	–0.239/0.038/0.139
BADS-SF	0.365/0.039/0.256	0.482/0.038/0.340	0.287/0.036/0.234	0.428/0.036/0.331

*NCP_{adj}, square root of NCP_{red} * IPS/PPS. All effects = $p < 0.001$ except * ≤ 0.05.*

NCP_{red}, the model explained an additional 6.4, 3.9, 16.3, 10.8, and 4.7% of the variation in SWLS, LoE, AMS-FF, GSE, and BADS-FF. This change (and the models with NCP_{red} term) was significant for all variables. Further, as seen in **Table 8**, NCP_{red} was the most important predictor (except LoE where IPS and NCP_{red} were equal). Similar results were observed for the second procrastination scale, PPS (see **Table 9**). In sum, these results indicate that the past negative consequences of procrastination measure (NCP) contributed to explaining the dependent variables above traditional procrastination measures, the IPS and PPS.

Finally, we compared the IPS, PPS, and NCP_{adj} by conducting linear regression analysis (performed separately for IPS, PPS, and NCP_{adj}). Since NCP_{red} does not contain information on the level of procrastination, IPS and PPS were compared with adjusted versions of NCP. Here, two adjusted versions were created, one using the IPS and one using the PPS. **Table 10** summarizes the results and demonstrates that the NCP_{adj}, in comparison to

both the IPS and PPS, was a better predictor and explained a larger proportion of variation in all dependent measures. Both adjusted versions of NCP performed better than their original counterparts. These results indicate that adjusted versions are superior to IPS and PPS, supporting the results of Study 1 and also our assumptions about limited importance of NCP.

GENERAL DISCUSSION

Delays may be rational and functional, but sometimes dysfunctional and irrational. The delays seen in procrastination are, by definition, irrational. A common definitional criterion is that procrastination is characterized by delaying "despite expecting to be worse off for the delay" and that the procrastinating individual "acts against better judgment." Examination of common procrastination scales demonstrates, however, that scales do not address these core characteristic of procrastination. In effect, there is a gap between the definition of procrastination and how it is measured in common scales.

Accordingly, the present paper explored the utility of a brief scale, the NCP, to supplement existing scales. Assuming that subjective past negative consequences of procrastination reflect the maladaptive and irrational aspects of this habit,[4] this scale should capture these aspects better than traditional scales. The NCP probes negative consequences of procrastinatory episodes over different domains and situations, as well as negative emotions and cognitions associated with such episodes, thus capturing a broad spectrum of troublesome sides associated with procrastination. In two studies, we demonstrated that this scale seems to tap the maladaptive aspects of unnecessary delay better than standard procrastination scales, here the IPS and PPS. Specifically, common procrastination scales demonstrate predictable negative relationships to scales measuring positive states (e.g., well-being, self-efficacy) and reliable positive relationships to scales measuring negative states (e.g., LoE). Comparing the NCP to established procrastination scales in the prediction of well-being, social loafing, and LoE (Study 1) and well-being, general self-efficacy, LoE, negative motivation, and mild depression tendencies (Study 2), the NCP seemed to be superior in predictions. Importantly, as the NCP identifies problems associated with past procrastination but does not itself contain information on procrastination levels, an improved NCP score is achieved by adjusting it for individual procrastination levels. We explored different ways of performing this adjustment. A simple approach is to adjust by using an established procrastination scale, here IPS or PPS. This alternative was systematically explored, and for every comparison, the adjusted NCP, the NCP_{adj}, outperformed the IPS and PPS in predictive ability.

An important implication of the present studies is that the NCP seems to capture a critical feature of procrastination, breakdown in self-regulation (e.g., Steel, 2007), better than traditional scales. As failure to self-regulate is associated with negative emotions (Tice and Bratslavsky, 2000; Tice et al., 2001), discomfort and negative cognitions/motions associated with procrastinatory episodes may be important criteria for maladaptive and irrational delays. This also applies to situations where the individual may achieve temporary emotional benefits from avoiding or escaping aversive work, as in short-term mood repair. Short-time mood repair is itself a sign of a breakdown in self-regulation, and negative emotions return (e.g., Sirois and Pychyl, 2013). Given that negative consequences – discomfort and negative cognitions/emotions – are connected intimately to a core problem in procrastination, failure to self-regulate, the NCP provides a simple means of capturing that core. Of note, whereas prior research has linked procrastination to negative affect in a general way (e.g., Krause and Freund, 2014), the present studies obtained a measure of discomfort and negative affect/cognition to procrastinatory episodes specifically.

By focusing on past NCP rather than forward-looking expectations, it may appear that we underestimate the ability of procrastinating individuals to assess their own procrastinatory behavior. We do not. First, research has amply documented that procrastinators are aware of their procrastination, both as a general dysfunctional habit (e.g., Steel, 2010) and in dealing with specific tasks (e.g., Tuckman, 1991). Second, we agree with the general definition of procrastination as a maladaptive delay in planned behavior, given the individual's own standard. Both criteria indicate that the procrastinating individual cognitively is capable of making plans as well as evaluating the factual progression in (not) realizing them. In fact, a core problem of procrastination is that those insights do not propel the individual to get things done. This problem, often named the intention-action gap (Steel et al., 2001; Steel, 2010), addresses implemental delays. The procrastination scales used in the present studies, the IPS and the PPS (Steel, 2010), focus on implemental delay. However, even these turned out to be rather indiscriminate in measuring procrastination, probably because they address delays in different forms, including those intention-action gaps that are trivial and inconsequential. The retrospective measure of the maladaptive consequences of procrastination explored in the present paper seems to demonstrate better construct validity. Overall, procrastination seems to account for only a limited amount of variance in the scales explored in the present studies. Still, that proportion seems to be measured more appropriately by the NCP, and especially the adjusted NCP, as this scale accounted for a larger proportion of the explained variance when compared to standard procrastination scales.

The NCP scale may be helpful in research as well as applied purposes. Self-report scales are often criticized, with behavioral procrastination measures (Miyake and Kane, 2021) or momentary assessment of procrastination in experience sampling (Wieland et al., 2018) suggested as better alternatives. However, the present results indicate an important advantage of self-report measures of procrastination over behavioral measures in that they, in a unique way, address the subjective criteria for problematic and irrational delays as distinct from delays that are unproblematic (e.g., Krause and Freund, 2014). Here, the NCP may help differentiate those forms of procrastination that reflect a maladaptive style of life from delays that are unnecessary but still inconsequential. As Díaz-Morales and Ferrari (2015) put it:

[4] See Grund and Fries (2018) for a recently proposed alternative explanation.

"*Everyone procrastinates, but not everyone is a procrastinator*" (p. 308, italics in original). Hence, an implication of the current studies is that unnecessary delay *per se* may not be as troublesome as having a history with procrastination-related negative consequences. The NCP seems to be capable of identifying (at least indirectly) the maladaptive and irrational sides of the procrastination habit.

The NCP may be a helpful tool in preventive as well as in clinical/applied settings. As for prevention, this scale may provide information on when and where procrastination has become problematic, thus helping educators and counsellors identify contexts that are especially appropriate for preventive measures. For example, if procrastination is especially problematic in the social domain, preventive measures may focus on social factors in the study environment (e.g., Codina et al., 2020). In clinical applications, the NCP scale may be a useful tool also. As discussed, not all delay is problematic. For example, Rozental et al. (2015) identified five main groups or clusters of procrastinators, with only 33% of participants representing severe instances of procrastination potentially requiring tailored treatment interventions. As procrastination-related negative feelings and cognitions are markers of problematic delay, the NCP may represent a good utility in clinical contexts where more precise information on problematic procrastination is needed. Also, the scale might be used to screen for participants' levels of problematic procrastination before entering a clinical trial or in creating create groups when conducting analyses to study the efficacy of interventions to reduce procrastination. In such cases, there is a need to distinguish general procrastination (as measured by standard scales) from maladaptive forms (as measured by the NCP). Also, as the NCP is capable of connecting maladaptive delays to specific domains/situations, interventions may be adapted to individual procrastination profiles in ways not possible when using standard scales. Here, the results from a study on academic procrastination by Steel and Klingsieck (2016) are particularly relevant. These authors identified a common factor important for all procrastinators, conscientiousness (and its facets, e.g., self-discipline, impulsiveness). However, after controlling for conscientiousness, students appeared to procrastinate for different reasons. For example, some procrastinated for social reasons (those high in extraversion), whereas others put off because of anxiety (those high in neuroticism). The NCP presents itself as a simple tool to identify individual procrastination profiles, which in turn may be of great utility in creating tailor-made interventions and assessing their effects.

Another important distinction relates to forms of delay that are rational and necessary for optimal goal-striving (e.g., strategic delay; Klingsieck, 2013). As discussed in this paper, commonly used procrastination scales do not contain items that explicitly differentiate trivial forms of delay from problematic delays. In addition, existing scales also often fail in identifying rational forms of delay as distinct from procrastination. Sometimes delayed action may be rational and even necessary for optimal goal striving. For example, a student might feel ready to submit her thesis in good time before the deadline, but submitting too early (precrastination) might induce unexpected costs in terms of lower quality and errors. Hence, delaying planned submission may be the rational thing to do. In general, timely action is important, both for the individual, for people interacting with the individual, and for society in general. When timely action is delayed (or rushed), negative consequences are likely to appear. Accordingly, although there may be somewhat blurred boundaries between them, at least three forms of delay should be differentiated:

(1) **Strategic and rational delays**. Delays that are *rational and often necessary for optimal goal striving* (e.g., delay submitting your thesis because your supervisor asked you to rewrite the discussion part).
(2) **Inconsequential delay**. Delays that are *unnecessary but bear no negative consequences* (e.g., reading a chapter on Wednesday rather than on Tuesday as preparation for a lecture on Friday).
(3) **Irrational delay**. Delays that are *maladaptive, given an intended goal* (e.g., not reading a chapter before a lecture even though the teacher strongly recommended you to).

The scale presented in the present paper, the NCP, seems to be capable of separating the two latter. Thus, a simple measure focusing on past negative consequences of unnecessary delay may be useful in separating trivial forms of unnecessary delay (2 above) from more severe forms (3 above). For research purposes, the NCP should be adjusted by a validated procrastination scale.

Limitations and Future Research

Several limitations of the present studies should be noted. First, as participants in the present studies were students only, using convenience samples, the next step would be to explore the NCP in a sample from the general population. Here, the item examples in the scale should be carefully examined, ensuring that they also reflect problematic consequences as perceived by non-students. Such a study should also apply more stringent methods to assess the scale, such as confirmatory factor analysis (CFA) and item response theory (IRT). Second, the sample sizes of the present studies may be considered as a limitation. Still, based on minimum sample size criteria for EFA (e.g., Kyriazos, 2018) and cross-validation of the factorial structure (Study 2), the NCP has acceptable empirical support. Nevertheless, future studies are advised to repeat the study with a larger sample. Third, the situations and domains probed in the present studies should be thoroughly examined. We selected a relatively broad spectrum of situations and domains to tap negative consequences of unnecessary delay, but other domains might be included. For example, we did not probe the health domain (e.g., Sirois and Pychyl, 2018), which is potentially important, especially as people get older. On the other hand, the present data indicate that even a reduced scale functioned very well, indicating that the scale might work well even if probes are taken from only a limited set of domains/situations. Fourth, given the broad classes of delay discussed in the previous section, a further step forward might be to develop a brief scale that probes the tendency to delay strategically and rationally. To the best of our knowledge, there is currently no scale that measures the first broad class mentioned,

the tendency to delay things that are rational and often necessary for optimal goal striving. Such a scale could complement the NCP in helping to achieve an even more precise delimitation of the phenomena we call procrastination.

CONCLUSION

The present paper explored the utility of a brief scale to measure past negative consequences associated with procrastinatory episodes. This scale seems to be helpful in separating trivial forms of unnecessary delay from maladaptive forms and helps identify the core problem in procrastination, maladaptive and irrational delay. As such, this scale represents a potentially valuable tool in research and clinical/applied efforts.

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 Department of Psychology, Ethics Committee. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FS initiated the project, drafted the manuscript, collected the data, and conducted the statistical analyses. EN contributed to the statistical analyses and overall refinement of the manuscript. Both authors edited the complete draft.

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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

The NCP Scale

Think of situations where you have put off planned and/or important tasks unnecessarily – you have "procrastinated."

When I think back on such situations, I must say that my procrastination resulted in. . .

. . .negative reactions from others (for example, that others remarked that I put off things unnecessarily).

. . .I perceived myself as inferior to others (for example, that others worked much faster than I did and finished tasks long before I did).

. . .that I missed opportunities (for example that I missed an important deadline).

. . .that I have lost something by being late (for example, that I was late in paying a bill and got a big fine).

. . .that I experienced lack of time or got behind (for example, that I did not read a recommended chapter before a lecture so that I did not understand the lecture).

. . .that I experienced negative feelings (for example, shame, regret, guilt, or worry).

. . .that I was disappointed in myself (for example, that I had expected to accomplish what I had planned but failed).

. . .that my belief that I am not good at finishing things was confirmed.

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Self-Report Measures of Procrastination Exhibit Inconsistent Concurrent Validity, Predictive Validity, and Psychometric Properties

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Procrastination is a chronic and widespread problem; however, emerging work raises questions regarding the strength of the relationship between self-reported procrastination and behavioral measures of task engagement. This study assessed the internal reliability, concurrent validity, predictive validity, and psychometric properties of 10 self-report procrastination assessments using responses collected from 242 students. Participants' scores on each self-report instrument were compared to each other using correlations and cluster analysis. Lasso estimation was used to test the self-report scores' ability to predict two behavioral measures of delay (days to study completion; pacing style). The self-report instruments exhibited strong internal reliability and moderate levels of concurrent validity. Some self-report measures were predictive of days to study completion. No self-report measures were predictive of deadline action pacing, the pacing style most commonly associated with procrastination. Many of the self-report measures of procrastination exhibited poor fit. These results suggest that researchers should exercise caution in selecting self-report measures and that further study is necessary to determine the factors that drive misalignment between self-reports and behavioral measures of delay.

Keywords: procrastination, pacing styles, psychometrics, predictive validity, concurrent validity, self-report measures

INTRODUCTION

Procrastination is a chronic and widespread problem, with some studies suggesting that one of every five adults engage in the behavior (Ferrari et al., 2007). Commonly, procrastination is identified through peoples' responses to self-report instruments. While research suggests these self-report instruments are strongly correlated with one another (e.g., Ferrari et al., 2005; Svartdal and Steel, 2017), emerging work raises questions regarding the strength of the relationship between self-reported procrastination and behavioral measures of task engagement (Krause and Freund, 2014; Kim and Seo, 2015; Imhof et al., 2021) or pacing (Vangsness and Young, 2020; Voss and Vangsness, 2020). Relatedly, recent research (Hussey and Hughes, 2020) and policy (Sackett et al., 2018) underscored a need to assess the psychometric properties and predictive validity of commonly used self-report instruments. Ideally, such tests would control for possible sources of variability such as sample characteristics, administration method, or task type (for a summary see Kim and Seo, 2015). To our knowledge, such a test has not been conducted on self-report measures of procrastination.

This paper summarizes literature documenting the alignment among self-report measures of procrastination (i.e., concurrent validity) and between self-report and behavioral measures of procrastination and pacing (i.e., predictive validity). We review several possible statistical and psychometric explanations for discrepancies that exist and then explore these explanations by testing the internal reliability, concurrent validity, predictive validity, and psychometric properties of 10 self-report measures of procrastination. In our discussion, we review our findings and offer several additional explanations for the inconsistencies we observed in the psychometric properties and predictive validity of self-report measures of procrastination.

Documented Relations Among Self-Reported Procrastination, Performance Measures, and Behavioral Delay

Historically, researchers have observed strong relationships among self-report measures of procrastination (e.g., Ferrari and Emmons, 1995; Specter and Ferrari, 2000; Sirois, 2007; Hen and Goroshit, 2018). This is an intuitive finding, given that many self-report measures of procrastination are created using items from other assessments and seek to assess the same underlying latent construct. For example, the Pure Procrastination Scale (PPS; Steel, 2010) includes items from Mann et al. (1997). Decisional Procrastination Scale, Lay's (1986) General Procrastination Scale, and the Adult Inventory of Procrastination (AIP; McCown et al., 1989). The PPS correlates highly with these instruments, with participants' scores on the PPS explaining at least 66% of the variability in their scores on the other instruments (Svartdal and Steel, 2017). Less intuitively, related measures share common method variance, which can inflate the strength of raw correlations between similar measures (Podsakoff et al., 2003).

In contrast, evidence for the predictive validity of self-report measures is mixed. Recent meta-analytic work suggests that self-report measures of procrastination demonstrate moderate predictive validity with measures of performance. Kim and Seo (2015) found that overall, self-report measures of procrastination explained only 2–11% of the variability in peoples' performance (i.e., significant correlation coefficients ranged from −0.13 to −0.33), depending on which procrastination instrument was used by the researcher. The strength of this relationship also depended on the measure of performance used by the researcher. For example, GPA explained only 1.4% of the variability in peoples' procrastination self-reports (r = –0.12), whereas individual assignment grades could account for 42% of this variance (r = –0.65). Interestingly, the strength of these relationships also depended on how the predictors were assessed. Self-report measures of procrastination shared a non-significant relationship with self-reported measures of performance (r = –0.08; 1% of variance explained) and were only moderately correlated with behavioral measures of performance (r = –0.15; 2% of variance explained). When procrastination and performance were both behaviorally assessed, the effect size was larger (r = –0.39; 15% of variance explained).

Relatedly, it is useful to consider the relationship between procrastination and pacing styles, "behavioral tendencies regarding the distribution of effort over time" (Gevers et al., 2015). Unlike procrastination, in which a person engages in a conscious and willful delay despite their knowledge of its negative outcomes (Klingsieck, 2013), pacing styles are defined more broadly and without negative connotation (Bloun and Janicik, 2002; Gevers et al., 2015). Endorsement of a deadline action pacing style—putting off task engagement until just before a deadline—is observed to correlate with self-reported procrastination (r = 0.55, or 30% of variance explained; Gevers et al., 2015). Although many researchers consider the deadline action pacing style as distinct from procrastination, self-report measures of procrastination frequently test predictive validity using behavioral measures of pacing style.

While published literature provides support for the relationship between self-report measures of procrastination and behavioral measures of pacing style, the size of these effects are mixed. Most of the zero-order correlation coefficients identified in our table research ranged from r = 0.17 to r = 0.45 (3–20% of variance explained; see **Figure 1**). Some large effect sizes do exist and are illustrated by the whiskers in **Figure 1**, but they are inconsistent across samples: Ferrari (1992) found that the Adult Inventory of Procrastination (AIP) explained 42% of the variance in the number of days it took non-traditional students to return a folder; however, this zero-order correlation was less robust for the sample of traditional college students, explaining only 16% of variability in the same behavior. In this same study, the AIP explained at most 2% of the variance in the time it took students to complete their final exam. More recently, Zuber et al. (2021) found that the voluntary and observed delay subscales of the PPS shared a significant correlation with the number of days it took students to email their instructors a signed document (r's = 0.41 and 0.47, respectively). Independently, these zero-order correlations explained 17% and 22% of the variability in students' behavior; when regressed together, they explained 27% of the variance in behavior. Steel et al. (2018) also observed rather high correlations between the IPS and a behavioral measure of pacing: area under the curve created by plotting students' cumulative assignment completion (r = 0.41, 17% of variance explained).

Statistical and Psychometric Explanations for Discrepancies Among Measures of Procrastination

The examples of published zero-order correlation coefficients, discussed in the previous paragraphs, test the predictive and concurrent validity of self-report measures of procrastination. Although all of the reported coefficients were significant at an alpha of .05, statistical significance does not necessarily provide support for concurrent or predictive validity. To interpret the zero-order correlation coefficients, readers must first consider

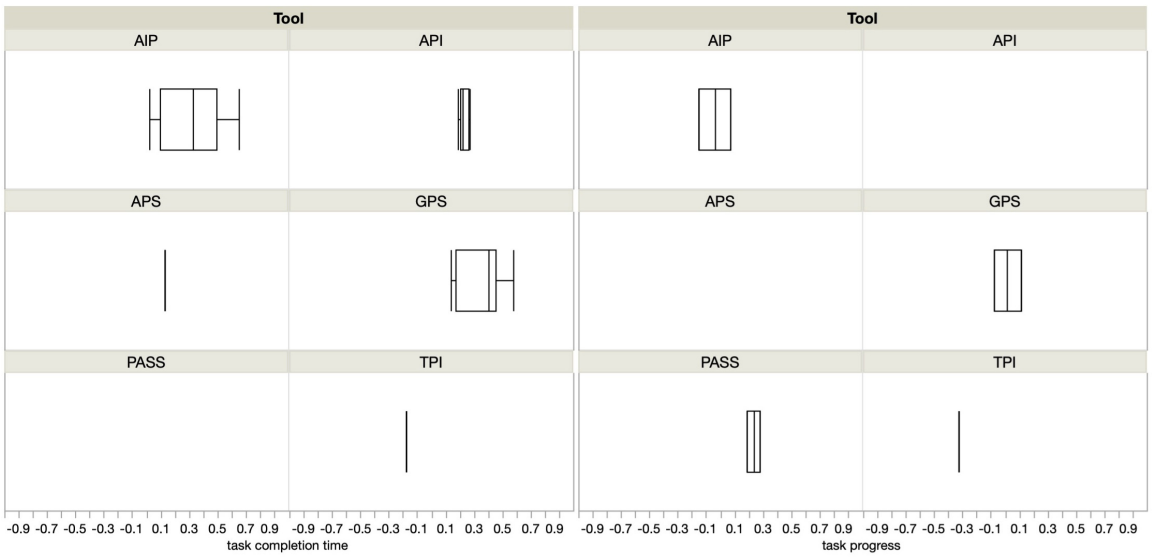

FIGURE 1 | Distributions of correlation coefficients depict the strength of the relationship between task completion time (left), task progress (right), and self-report measures of procrastination.

the researchers' sample size, the number of statistical tests that were conducted, the psychometric properties of the scales that are being used, and the impact of nuisance variables on behavioral data.

Sample Size

Large samples have greater power to detect a statistically significant relationship between two predictors, even when that relationship is small. For example, Meehl (1990) described the results he obtained from a large-scale (N = 57,000) state survey database. Of the 990 analyses he conducted on this data, 92% were statistically significant. Meehl (1990) noted that these were not Type I errors, but rather stable—but small—relationships observed within the sample. That these relationships were statistically significant says more about researchers' certainty in the presence of an effect than it does about whether the effect is large enough to be meaningful or generalize out-of-sample. It is possible that a similar issue affects the generalizability of procrastination studies with extremely large samples.

For this reason, many statisticians promote effect size over statistical significance (e.g., Royall, 1986; Tukey, 1991; Cohen, 1994; Kirk, 1996), with an emphasis on the "practical significance" (Royall, 1986; Kirk, 1996) of the effects. Relatedly, meta-analyses, such as Kim and Seo's (2015) work, can allow researchers to identify stable relationships and determine how they change relative to study characteristics such as instrument and sample characteristics (Kirk, 1996). This may help explain why overall, self-report measures of procrastination explained only 1% of the variance in peoples' self-report performance and 2% of the variance in peoples' behavioral measures of performance, but that individual measures (e.g., specific assignment grades) fared much better (Kim and Seo, 2015).

Number of Statistical Tests

A separate explanation for the inconsistent relationship between self-report and behavioral measures has to do with inflated Type I error rates associated with many pairwise comparisons. A typical psychology publication reports a Type I error rate of .05. Functionally, this threshold requires the researchers—and the reader—to assume the risk that a single significant relationship has a 5% chance of being a false discovery. This error rate is unique to each statistical test; therefore, in papers that report multiple tests (e.g., all possible pairwise comparisons; multiple correlation tables; etc.), the Type 1 error rate is equal to $1 - (1 - \alpha)^c$, where c represents the number of tests conducted (Keppel and Wickens, 2004, p. 112). For example, one of the studies reported in this paper contains 14 statistical tests, of which four were statistically significant. This set of analyses ran at least a 51% chance of making a false discovery. Therefore, it is possible that some of the significant relationships that emerge in studies that conduct multiple pairwise comparisons will not generalize—or will appear as a smaller effect—in a different sample.

Psychometric Properties

Another important consideration for assessing the relationship between self-report measures of procrastination and behavioral outcomes concerns the nature of self-report measures themselves. As noted above, self-report measures of procrastination are not typically strong predictors of behavior (but see Zuber et al., 2021). Poor psychometric properties are one potential explanation for why self-report measures may not adequately predict behavior. For a measure to be valid, it must possess acceptable psychometric properties such as high reliability, good model-data fit, and measurement invariance (MI; e.g., Hussey and Hughes, 2020). It must also be related to theoretically relevant constructs

(i.e., possess concurrent validity) and unrelated to theoretically irrelevant constructs (i.e., possess discriminant validity). When a measure is lacking any of these properties, it lacks sufficient evidence for construct validity and does not sufficiently measure what it is supposed to be measuring. If a measure is not properly assessing procrastination, it is unlikely to predict procrastination behavior. Of course, it is still possible for self-report measures with poor psychometric properties to be significantly related to other variables. In such cases, these relations are meaningless since the measures themselves lack evidence of construct validity.

Impact of Nuisance Variables on Behavioral Data

A final explanation for the small effects observed in the literature is the influence of nuisance variables on behavioral measures of delay and performance. Previous empirical (e.g., Epstein, 1979; Abelson, 1985) and philosophical (Epstein, 1983) works note that behavioral measures are influenced by a variety of uncontrolled factors (i.e., nuisance variables such as competing tasks or fatigue) that increase error variance and can obscure the true relationship between self-report and behavioral measures. In such cases, repeated-measures approaches to data analysis—such as aggregation (Epstein, 1983) or multi-level modeling (Gelman and Hill, 2006)—statistically control for nuisance variance and yield estimates that are more reflective of the true relationship between self-report and behavioral measures. This is especially true for traits, which influence behavior but can be overshadowed by context-specific factors (Mischel, 1977). If nuisance variables obscure the relationship between self-report measures of procrastination and behavioral measures of delay or performance, aggregated measures (e.g., GPA, pacing style, course grade) should hold stronger relationships with self-report measures than do disaggregated measures (e.g., assignment grade). Interestingly, this appears to be the opposite relation as was observed among measures of performance in Kim and Seo's (2015) meta-analysis. Nevertheless, it is worthwhile to consider whether single index measures of procrastination (e.g., completion date) perform more poorly than aggregate measures (e.g., behavioral measures of pacing style).

TABLE 1 | Sample demographic information.

Demographic characteristic	*N*
Sex	
Female	165
Male	63
Other	2
Prefer not to say	5
Race	
White	155
Black	22
Asian	30
Hispanic/Latinx	24
Native Hawaiian/Pacific Islander	1
American Indian	0
Prefer not to say	3

The Current Study

Understanding the relationship between self-report measures of procrastination and behavioral outcomes requires more than simply examining the zero-order correlations between these two types of measures. It also requires a holistic consideration of sample size, the number of tests conducted, and the psychometric properties/construct validity of the measures that are employed. Therefore, we chose to assess the convergent and predictive validity of 10 self-report measures of procrastination using cluster analysis (Gore, 2000) and Lasso estimation (Tibshirani, 1996), two statistical approaches that control for the family-wise errors inherent in repeated analysis and the multicollinearity present among related measures. The study was conducted over the course of an entire semester and involved a task with a distant deadline, providing ample opportunity to measure procrastination and students' pacing styles. We also examined the psychometric properties of 10 self-report procrastination measures via confirmatory factor analysis (CFA).

MATERIALS AND METHODS

Participants

Research participants were psychology students currently enrolled at Wichita State University. All research procedures were approved by the Institutional Review Board at Wichita State University. Qualtrics was used to obtain participants' consent and to administer an online battery of self-report instruments to 242 students; seven did not click through to the end of the survey and were excluded from analyses. The remaining 235 participants (μ_{age} = 22, SD_{age} = 7.14) completed all 10 survey instruments in exchange for four research credits. Demographic information about these participants is available in **Table 1**.

Procedure

Participants completed an online survey comprised of 10 well-known self-report measures of procrastination (for details, see section "Self-Report Measures"). Five directed response (e.g., Please select "Agree" when responding to this item.) and five bogus items (e.g., I do not understand a word of English.) were evenly spaced throughout the battery to ensure that participants were paying attention (Meade and Craig, 2012). Students answered five, fixed-order demographics questions before completing the procrastination surveys—and the items within them—in a randomized order. A 5 (*strongly agree*) to 1 (*strongly disagree*) scale was adopted for all measures except the PASS, which employed a 5 (*always*) to 1 (*never*) scale; higher scores indicated greater levels of procrastination. Surveys were evenly administered over the course of the 16-week semester to ensure that the study would be completed by students exhibiting a variety of pacing styles. The survey took around 30 min to complete and could be returned to at any time for up to a week. A full copy of the survey and its randomization information can be found at the project's OSF page: https://osf.io/r7wcx/.

Self-Report Measures

Self-report measures of procrastination were selected with an eye toward utility. The instruments that follow are widely used by researchers studying procrastination, and all have undergone some degree of validation.

Metacognitive Beliefs About Procrastination

The MBP is a 14-item survey that requires people to endorse statements about the emotions and thoughts that drive procrastination (e.g., "Procrastination stops me from making poor decisions when I am feeling anxious"; Fernie et al., 2009). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated more positive beliefs about procrastination. This instrument was initially validated through exploratory and CFA, as well as internal consistency reliability (Fernie et al., 2009).

Academic Functional Procrastination

The AFP is a 9-item survey that invites respondents to endorse statements related to procrastination within an academic context (e.g., "I have procrastinated on my lessons in some cases in order to be motivated for them"; Kandemir and Palanci, 2014). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to a strategic use of academic procrastination. This instrument was originally validated through exploratory factor analysis, CFA, and internal consistency reliability (Kandemir and Palanci, 2014).

Lay's General Procrastination Scale

The 16-item GPS allows participants to endorse general statements about procrastination (e.g., "I usually make decisions as soon as possible"; Lay, 1986). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination. This instrument's initial validation involved tests of predictive, concurrent, and divergent validity (Lay, 1986). Subsequent factor analysis and principal components analysis have been conducted by Vesterveldt (2000), Svartdal and Steel (2017), and Klein et al. (2019).

Adult Inventory of Procrastination

The 10-item AIP requires respondents to rate the degree to which they endorse general statements about procrastination (e.g., "My friends and family think I often wait until the last minute"; McCown et al., 1989). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination. This instrument was initially validated through principal components analysis (McCown et al., 1989). Subsequent factor analysis and principal components analysis have been conducted by Vesterveldt (2000) and Svartdal and Steel (2017).

Active Procrastination Scale

The APS invites participants to indicate the degree to which they use procrastination as a motivational tool (e.g., "I intentionally put off work to maximize my motivation"; Choi and Moran, 2009). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to active procrastination. This instrument was originally validated through assessments of concurrent and divergent validity, exploratory and CFA, internal consistency reliability, and predictive validity (Choi and Moran, 2009). Subsequent validation has been conducted by Pinxten et al. (2019).

Unintentional Procrastination Scale

The UPS is a 7-item assessment that requires participants to endorse general statements about procrastination (e.g., "I often seem to start things and don't seem to finish them off"; Fernie et al., 2017). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination. This instrument was initially validated through principal components analysis, concurrent and divergent validity, exploratory and CFA, and internal consistency reliability (Fernie et al., 2017).

Procrastination Assessment Scale for Students

The PASS is a 12-item assessment that allows people to rate the degree to which they procrastinate on school-related tasks (e.g., "To what degree is procrastination on *attendance tasks* a problem for you?"; emphasis original; Solomon and Rothblum, 1984). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination for academic tasks. This instrument has been intentionally validated through predictive validity, exploratory factor analysis, and concurrent validity (Solomon and Rothblum, 1984); subsequent factor analyses have been conducted by Yockey and Kralowec (2015).

Irrational Procrastination Scale

The IPS is a 9-item scale that asks participants to endorse statements related to the irrationality of procrastination (e.g., "At the end of the day, I know I could have spent the time better."; Steel, 2010). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination. This instrument has been intentionally validated through exploratory factor analysis, CFA, and internal consistency reliability (Steel, 2010).

Pure Procrastination Scale

The PPS is a 12-item scale that requires participants to endorse general statements about procrastination (e.g., "I am not very good at meeting deadlines"; Steel, 2010). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination. This instrument was initially validated through exploratory factor analysis, CFA, and internal consistency reliability (Steel, 2010). Subsequent factor analysis has been conducted by Svartdal and Steel (2017).

Tuckman's Procrastination Scale

The TPS is a 16-item instrument that invites participants to endorse general statements related to procrastination (e.g., "I get stuck in neutral even though I know how important it is to get started; Tuckman, 1991). Participants' responses to these items were averaged together to create a composite score that ranged from 1 to 5, where higher scores indicated a stronger endorsement of statements related to procrastination. This instrument was initially validated through exploratory factor analysis, CFA, internal consistency reliability, and predictive validity (Tuckman, 1991).

Behavioral Measures of Delay

In addition to providing self-reports, we also employed two behavioral measures of delay to test the predictive validity of the self-report measures of procrastination. These measures were derived from the dates of students' research appointments recorded in the Sona Systems database (Sona Systems, 2021), our institution's experiment management system. Research participation requirements are shared in syllabi, worth course credit, and have deadlines. The students in our sample all needed to complete 16 credits before the end of the semester. These students were aware that failing to complete their research credits would be disadvantageous—it would negatively impact their grade—and were reminded of this fact several times throughout the semester. Research appointments were available throughout the semester. Therefore, delaying the completion of a single research credit by a few weeks (especially early in the semester) would not place students in danger of failing the assignment. However, a pattern of delay exhibited across the course of the semester would, as research appointments are a limited resource. These circumstances gave rise to "weak" situations (Mischel, 1977) in which individual differences in pacing style were expected to be especially pronounced (Gevers et al., 2015). Thus, these measures represented a meaningful way to test predictive validity of these self-report instruments (Vangsness and Young, 2020).

Days to Study Completion

Days to study completion was assessed by computing the number of days into the semester on which a student completed our research study, according to the registrar's calendar and the records from the SONA system. Each semester was 16 weeks (112 days) long. Researchers have used similar measures of delay to demonstrate the predictive validity of self-report measures (e.g., Solomon and Rothblum, 1984; Lay, 1986; Ferrari, 1992; Reuben et al., 2015) or to identify procrastination behavior among participants (e.g., Steel et al., 2001).

Pacing Styles

Pacing styles were assessed by treating students' research participation records as a distribution that could be described by three characteristics: task initiation (day of first research credit completion), central tendency (average completion day), and spread (completion distribution; *SD*). We subjected these three measures to a latent profile analysis (LPA), using the procedure outlined in Vangsness and Young's (2020) methodological paper. Students' profile membership was then used to create a binary outcome variable where students who exhibited a deadline action pacing style were assigned a 1 and all other students (i.e., precrastinators/early action pacing and steady working) were assigned a 0.

Statistical Approach

Psychometric and predictive validations were conducted in R (R Core Team, 2020) as two-tailed tests with an alpha of 0.05, while the cluster analysis was conducted with JMP Pro 15. All procedures are freely available through the project's OSF page, and the analyses can be reproduced using the provided data file, which has been anonymized and stripped of identifying information to preserve students' confidentiality.

Selection of Sample Size

Post-hoc power analyses were conducted for all analyses. The study sample provided between 58 and 88% power to detect the observed effects. Code and graphical illustrations of the power analyses are available on the project's OSF page.

Psychometric Analyses

The quality of the self-report measures of procrastination was assessed via a series of CFA models and MI analyses (Vandenberg and Lance, 2000). The CFA models were estimated to align with the factor structures proposed by the authors of these scales. To evaluate the fit of these models, we relied on standard thresholds for several model fit indices (e.g., CFI $\geq$ 0.95, RMSEA $\leq$ 0.08; Hu and Bentler, 1999). We conducted MI analyses on the scales by using pacing style as the grouping variable (see Voss and Vangsness, 2020): those who employed a deadline action pacing style and those who did not (i.e., engaged in early action or steady work pacing). We employed a CFA approach by estimating a series of increasingly constrained models where the factor structures (configural invariance), factor loadings (metric invariance) and item intercepts (scalar invariance) were constrained to be equal across groups. When comparing models, we relied on both $\Delta\chi^2$-values and ΔCFI values since χ^2 is overly sensitive to sample size (Brown, 2006). We considered models with a significant $\Delta\chi^2$-value and ΔCFI > 0.01 as representing a substantive difference between models (Vandenberg and Lance, 2000).

Cluster Analysis

K-means cluster analysis (Gore, 2000; Wu, 2012) was used to determine the degree to which participants' self-report composite scores aligned with one another. We employed the standard measure of similarity (Euclidean distance) and used Cubic Clustering Criteria (CCC) values to select an appropriate clustering solution. Because participants' responses to the survey instruments were collected and averaged using a 5-point scale, further standardization of the data was not necessary.

Lasso Estimation and Regressions

We assessed the relationship between the self-report and behavioral measures of delay with lasso estimation. The lasso modeling approach incorporates a penalty against

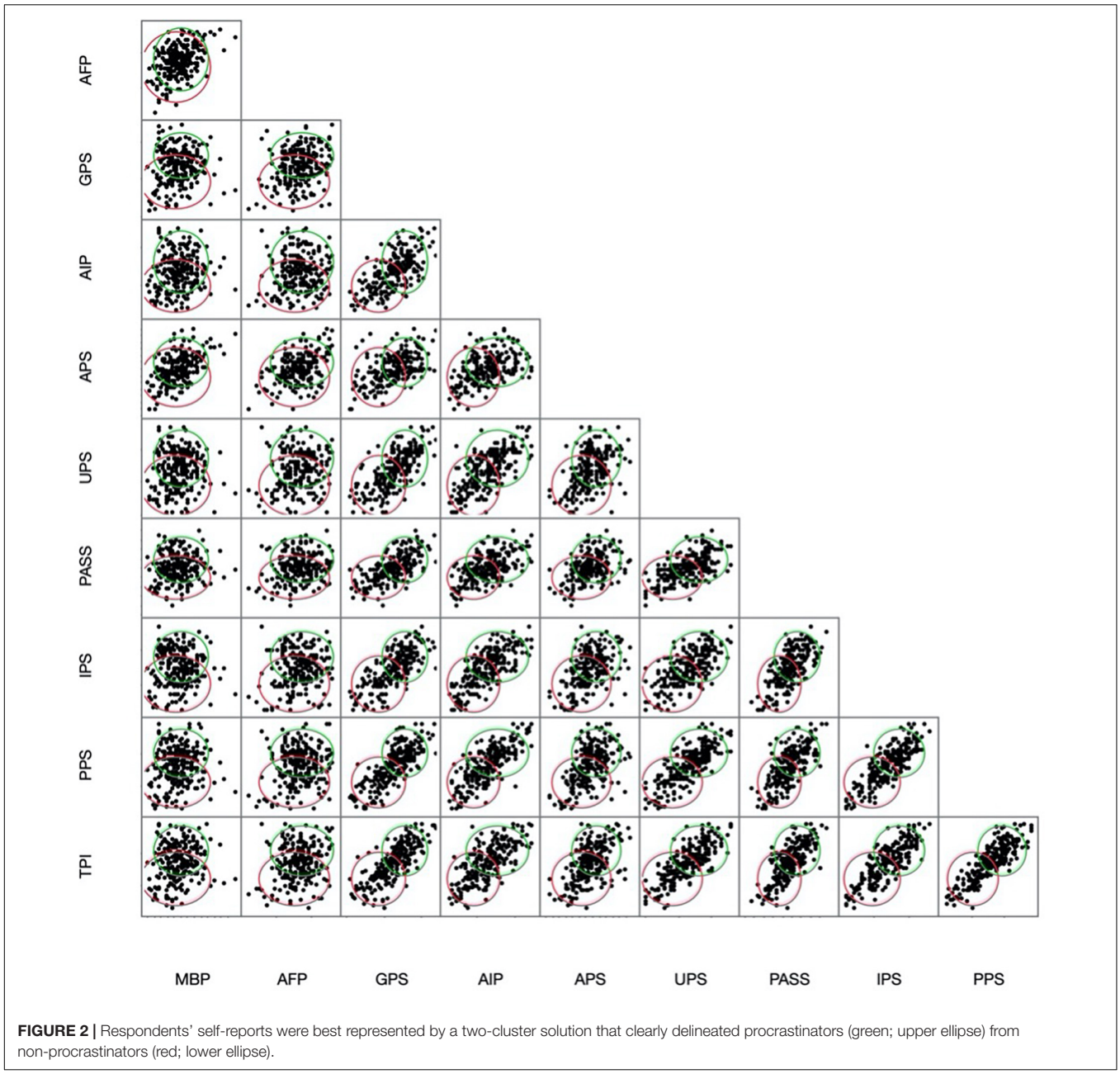

FIGURE 2 | Respondents' self-reports were best represented by a two-cluster solution that clearly delineated procrastinators (green; upper ellipse) from non-procrastinators (red; lower ellipse).

individual parameter estimates, encouraging sparser models. This approach is particularly useful when there is low-to-moderate multicollinearity among the predictors of a dataset (Tibshirani, 1996; Schreiber-Gregory and Jackson, 2017), as was the case in this study. The estimation penalty (i.e., lambda) was selected using the cross-validation function provided by the glmnet package in R. This cross-validation function runs a 10-fold cross-validation on the data using 100 possible values of lambda. The selected value is the one that minimizes the mean cross-validated error. We planned to follow up on the relationships identified by the lasso with logistic and Poisson regressions, which take into account the unusual error distribution exhibited by binomial (i.e., deadline action vs. other pacing styles) and count variables (i.e., days to study completion). These analyses provided easier-to-interpret parameter estimates, standard errors, and significance values.

RESULTS

Careless Responding

Participant responses to the attention check items in our survey indicated that our participants were well-attentive: 160 Students answered all these questions correctly, and 60 students missed only one of the questions. Therefore, all data were retained for subsequent analyses.

TABLE 2 | Current and historic measures of reliability for self-report procrastination assessments.

Self-report measure	$\alpha_{current}$	$\alpha_{historic}$
Metacognitive Beliefs about Procrastination (MBP)		
Positive Beliefs Subscale	0.74	0.81
Negative Beliefs Subscale	0.80	0.85
Academic Functional Procrastination (AFP)	0.79	–
Lay's General Procrastination Scale (GPS)	0.87	0.82
Adult Inventory of Procrastination (AIP)	0.83	0.76
Active Procrastination Scale (APS)	0.76	0.80
Unintentional Procrastination Scale (UPS)	0.83	–
Procrastination Assessment Scale for Students (PASS)	0.90	0.85
Irrational Procrastination Scale (IPS)	0.85	0.91
Pure Procrastination Scale (PPS)	0.90	0.86
Tuckman's Procrastination Scale (TPS)	0.93	0.90

Cronbach's alpha was not reported in the original publications of the AFP, UPS, and PASS; Solomon and Rothblum (1984) did not assess the internal reliability of this measure in their original publication; subsequent alphas range from 0.66 to 0.85.

Internal Reliability

Cronbach's (1951) alpha was used to assess the internal reliability of self-report measures of procrastination.[1] In general, all of the procrastination measures exceeded the recommended threshold of 0.70 (Lance et al., 2006) and bore similarity to those reported in past studies (see **Table 2**). In general, participants' responses were well-aligned within a single instrument.

Concurrent Validity of Self-Report Measures

CCC values indicated a two-cluster solution was most appropriate for the data (see **Figure 2**). Cluster means (see **Table 3**) indicated that the two clusters could be characterized as follows:

1. Procrastinators (n = 94): scored highly on forward-coded measures, excluding the PASS, which was reverse-coded.
2. Non-Procrastinators (n = 123): scored low on forward-coded measures, excluding the PASS.

Although these clusters were consistent with researchers' current understanding of procrastination, differentiation was driven by some self-report measures more than others. This phenomenon is illustrated in **Figure 2**, which contains density ellipses that encircle 90% of the students included in each cluster. These ellipses are overlaid on a correlation matrix. The separation of the ellipses corresponds with the degree to which each set of assessments contributes to identifying procrastination among the members of the sample; in cases where instruments are highly correlated, the data and ellipses are spread along the diagonal. Cluster means revealed that classifications were predominantly driven by participants' scores on the PPS, TPS, UPS, IPS, AIP, and GPS. This is illustrated by the clear separation in cluster ellipses across these panels in **Figure 2**. These measures were also highly correlated with one another (see **Table 4**), a relationship that is reflected in the diagonal separation of cluster ellipses for these measures. Therefore, the self-report measures largely exhibited concurrent validity with one another.

[1]Although other metrics (e.g., McDonald's coefficient) are recommended for instruments with a high number of items, we used Cronbach's alpha to facilitate comparisons with published literature, which uses this measure of internal reliability almost exclusively.

TABLE 3 | Cluster means illustrate the degree to which individual self-report measures of procrastination differentiated procrastinators from non-procrastinators.

Predictor	Procrastinators	Non-procrastinators	Δ
Pure Procrastination Scale (PPS)	3.51	2.18	1.33
Tuckman's Procrastination Scale (TPS)	3.59	2.32	1.27
Unintentional Procrastination Scale (UPS)	3.57	2.34	1.23
Irrational Procrastination Scale (IPS)	3.70	2.55	1.15
Lay's General Procrastination Scale (GPS)	3.45	2.40	1.05
Adult Inventory of Procrastination (AIP)	2.91	1.96	0.95
Procrastination Assessment Scale for Students (PASS)	3.43	2.49	0.94
Active Procrastination Scale (APS)	3.00	2.44	0.56
Academic Functional Procrastination (AFP)	3.72	3.39	0.33
Metacognitive Beliefs about Procrastination (MBP)	2.62	2.42	0.20

Pacing Styles

The pacing styles identified by our LPA mirrored those found previously (see **Figure 3**). Specifically, one latent profile ("precrastination") represented students who engaged in an early action pacing style by starting their research credits early and quickly completing them at the beginning of the semester. Another profile ("steady work") represented students who engaged in a steady work pacing style by starting their research credits early and methodically participating in research until the end of the semester. The last profile ("procrastination") represented students who exhibited a deadline action pacing style by starting their research credits late in the semester and quickly completing them before the deadline. These patterns were similar to those found in previous work despite in-person classes being canceled due to the COVID-19 pandemic. This is likely to due to the increased number of online studies available at the first author's institution. Interestingly, the number of people engaging in procrastination-like task completion strategies (n = 57) was lower than the number of procrastinators identified by cluster analysis, a classification strategy that relied solely on self-report measures.

Confirmatory Factor Analysis

As seen in **Table 5**, the CFA (estimated via maximum likelihood) fit of these models (labeled "*Baseline Fit*") was generally unacceptable apart from a few scales (e.g., UPS, IPS, and TPS). The psychometric issues that we identified with the scales were

TABLE 4 | Correlations between individual survey instruments and continuous behavioral measures.

	MBP	AFP	GPS	AIP	APS	UPS	PASS	IPS	PPS	TPS
MBP										
AFP	**0.47**									
GPS	0.15	**0.25**								
AIP	0.14	0.10	**0.66**							
APS	**0.55**	**0.46**	**0.49**	**0.44**						
UPS	0.07	0.13	**0.70**	**0.67**	**0.45**					
PASS	0.14	0.20	**0.69**	**0.59**	**0.48**	**0.63**				
IPS	0.09	0.14	**0.75**	**0.74**	**0.47**	**0.68**	**0.70**			
PPS	0.12	0.15	**0.78**	**0.76**	**0.49**	**0.79**	**0.71**	**0.82**		
TPS	0.15	0.19	**0.77**	**0.70**	**0.53**	**0.79**	**0.75**	**0.82**	**0.86**	
DSS	0.19	–0.02	0.13	0.06	0.15	0.09	0.21	0.18	0.16	0.19

DSS = Days Since Start (behavioral delay). Values in bold are statistically significant at the 0.001 level (0.05 Bonferroni-corrected for multiple pairwise comparisons).

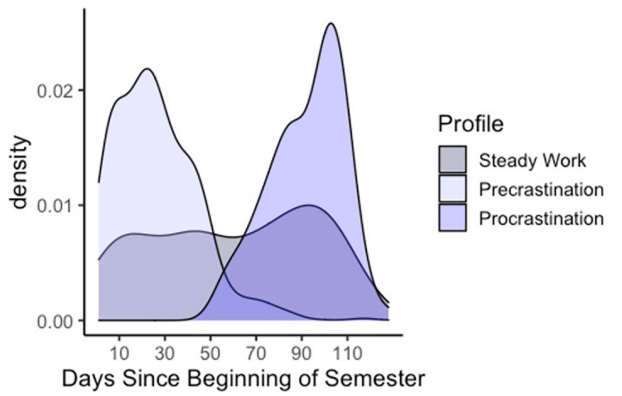

FIGURE 3 | Students' research credit completion strategies were identified as precrastination, steady work, and procrastination.

inconsistent and included mis-specified factor structures, item cross-loadings, and highly collinear item residuals. In many ways, these results are not surprising given that similar issues have been observed for many of these scales within the previous literature (e.g., PASS, Yockey and Kralowec, 2015; GPS, Klein et al., 2019; APS Pinxten et al., 2019; AIP, Svartdal and Steel, 2017; PPS, Svartdal and Steel, 2017).

Measurement Invariance

Pacing style served as the grouping variable for the MI analyses. As seen in **Table 5**, a significant $\Delta\chi^2$-value was observed for two models (Metric invariance for the MBPS and the PPS). However, the ΔCFI for these models was not greater than 0.01, so it is unlikely that their fit deteriorated enough to represent a violation of MI. Thus, it appears that the psychometric properties of these self-report procrastination scales are largely equivalent regardless of one's task completion strategy. Put another way, these findings suggest that the self-report procrastination scales function similarly (e.g., are interpreted in a similar manner) for people whose task completion strategies mirror those of procrastination and non-procrastination. Some caution is

TABLE 5 | Summary of the confirmatory factor analysis (CFA) and measurement invariance (MI) models for all self-report procrastination scales.

	Model fit indices				
Variable	χ^2	**AIC**	**CFI**	**RMSEA**	$\Delta\chi^2$
MBPS					
Baseline fit	235.96**	8,130	0.80	0.10	–
Configural invariance	354.76**	8,201	0.76	0.11	–
Metric invariance	378.56**	8,200	0.75	0.11	23.79*
Scalar invariance	383.81**	8,182	0.76	0.11	5.25
AFPS					
Baseline fit	81.99**	5,157	0.86	0.10	–
Configural invariance	113.65**	5,205	0.85	0.11	–
Metric invariance	120.01**	5,195	0.86	0.10	6.35
Scalar invariance	121.94**	5,181	0.87	0.09	1.93
LGPS					
Baseline fit	235.48**	9,102	0.84	0.09	–
Configural invariance	358.01**	9,185	0.81	0.10	–
Metric invariance	368.62**	9,168	0.82	0.09	10.61
Scalar invariance	381.89**	9,153	0.82	0.09	13.28
AIP					
Baseline fit	154.49**	5,831	0.79	0.13	–
Configural invariance	203.17**	5,883	0.77	0.14	–
Metric invariance	208.10**	5,870	0.78	0.13	4.93
Scalar invariance	217.38**	5,861	0.78	0.12	9.28
APS					
Baseline fit	270.57**	9,551	0.83	0.09	–
Configural invariance	384.38**	9,650	0.82	0.10	–
Metric invariance	391.06**	9,633	0.82	0.09	6.68
Scalar invariance	398.84**	9,616	0.83	0.09	7.78
UPS					
Baseline fit	37.40**	4,253	0.94	0.09	–
Configural invariance	56.24**	4,293	0.93	0.10	–
Metric invariance	62.37**	4,287	0.93	0.09	6.13
Scalar invariance	67.06**	4,279	0.94	0.08	4.69
IPS					
Baseline fit	79.92**	5,087	0.91	0.10	–
Configural invariance	101.23**	5,123	0.92	0.09	–
Metric invariance	109.36**	5,115	0.92	0.09	8.13
Scalar invariance	124.87**	5,115	0.91	0.09	15.51
PPS					
Baseline fit	177.45**	6,993	0.89	0.11	–
Configural invariance	232.75**	7,051	0.89	0.11	–
Metric invariance	251.24**	7,051	0.88	0.11	18.49*
Scalar Invariance	260.10**	7,042	0.88	0.11	8.85
TPS					
Baseline fit	194.52**	9,044	0.94	0.07	–
Configural invariance	296.24**	9,114	0.94	0.06	–
Metric invariance	308.57**	9,096	0.94	0.06	12.33
Scalar Invariance	328.15**	9,086	0.94	0.06	19.59

**p < 0.05, **p < 0.01. Baseline fit refers to the fit across all groups. The grouping variable for the measurement invariance analysis consisted of the procrastinators and non-procrastinators (precrastinators and steady work groups) identified by the latent profile analysis. We were unable to estimate an appropriate model for the PASS.*

warranted in interpreting these results, however, since these groups were somewhat smaller than what is conservatively recommended for MI testing. More importantly, the baseline fit for most of the self-report scales was rather poor. Thus, aside from the few good fitting models (see **Table 6**), the MI results are unfortunately somewhat tenuous for many of the scales that we assessed.

Predictive Validity of Self-Report Measures

Pacing Styles

The lasso dropped all of the predictors (i.e., shrunk their regression weights to 0), suggesting that self-report measures of procrastination are not predictive of this behavioral measure of delay.

Days to Study Completion

The lasso dropped only three self-report measures of procrastination: the GPS, the APS, and the PPS. Subsequent Poisson regressions indicated that days to study completion could be predicted by participants' self-reports on the MBP ($B = 0.19$, $SE = 0.02$, $z = 12.28$, $p < 0.001$), the AIP ($B = 0.04$, $SE = 0.01$, $z = 3.62$, $p < 0.001$), the UPS ($B = 0.06$, $SE = 0.01$, $z = 5.90$, $p < 0.001$), the PASS ($B = 0.16$, $SE = 0.01$, $z = 13.71$, $p < 0.001$), the IPS ($B = 0.13$, $SE = 0.01$, $z = 11.83$, $p < 0.001$), and the TPS ($B = 0.12$, $SE = 0.01$, $z = 12.24$, $p < 0.001$). Students' self-report responses to each of these measures shared a positive relationship with task-specific procrastination; however, the instruments did not exhibit equally strong effects, as evidenced by the slopes in **Figure 4**. The strongest predictor of task-specific delay was the MBP. Students who endorsed the items on this instrument most strongly completed the research study 53 days later than those who endorsed these items the least (100 and 47 days, respectively). The next strongest measure was the PASS, for which the highest- and lowest-scoring students differed by 41 days (86 and 45 days, respectively). Those who reported the highest levels of procrastination on the AIP completed the study 9 days later than those who reported the lowest levels of procrastination (68 and 59, respectively). The IPS and TPS were similarly predictive, with the highest scoring students on each instrument completing the study 32 days ahead of the lowest scoring students (79 and 47, respectively; 80 and 48, respectively). The least predictive instruments were the UPS and the AFPS, with the highest scoring students completing the study on average 15 and 4 days ahead of their lowest-scoring peers (56 and 71; 62 and 66, respectively). Poisson regression suggested that the relationship between the AFPS and the day on which participants completed the research study was weak and unlikely to generalize out-of-sample ($B = -0.02$, $SE = 0.01$, $z = -1.36$, $p = 0.17$).

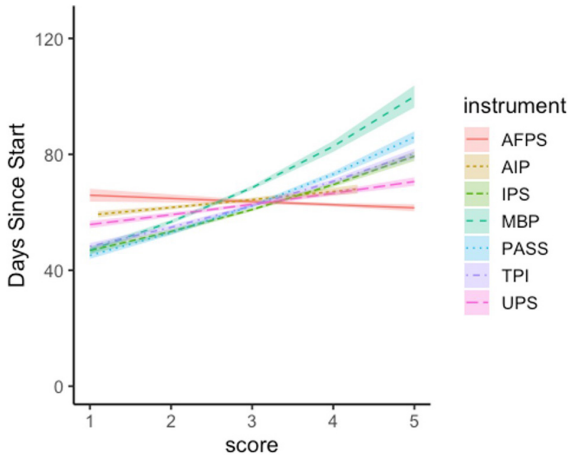

FIGURE 4 | Respondents' scores on many of the self-report measures of procrastination predicted the amount of time that elapsed before they completed the research study. The strength of this relationship differs across instruments. Error bars represent ±1 *SE*.

DISCUSSION

Our results found that some self-report measures of procrastination exhibited better psychometric properties and displayed stronger predictive validity than did others. While all of the instruments exhibited good internal reliability, concurrent validity, and displayed MI, only the UPS, IPS, and TPS had consistent factor structures. We also discovered that the self-report measures predicted behavioral delay to varying degrees. Some of the measures we compared (i.e., MBP, PASS, TPS, IPS) were stronger predictors of behavioral delay than were others (i.e., UPS, AIP, AFP). A subset of measures (i.e., GPS, APS, and PPS) did not predict our behavioral measures of delay at all. Additionally, none of the self-report measures predicted engagement in a deadline action pacing style throughout the semester. This is especially notable, given that the deadline action pacing style is expected to be positively related to self-reported procrastination, especially when a task's structure affords people great freedom to choose when and how they complete it (Gevers et al., 2006). While the poor predictive power of self-report measures is sometimes attributed to the presence of nuisance variables (e.g., Mischel, 1977; Epstein, 1979, 1983; Funder, 2012), our results were not consistent with this perspective. Therefore, we turn to alternative explanations for our observed relations.

Although the results can be partially explained by poor psychometric properties (e.g., the GPS), this is not true of all instruments. Therefore, it is likely that other factors contribute to the discrepancies we observed. Students may lose self-awareness of their task completion strategies when they are distributed over time, leaving their self-reports poorly predictive of their pacing style. Alternatively, pacing style and procrastination may be entirely unrelated constructs. Finally, some of these results may be explained by the poor psychometric properties of the instruments.

Students May Lack Awareness of Their Task Completion Strategies

Procrastination has been described as an irrational behavior that occurs when a person fails to complete tasks that they know

TABLE 6 | Summary of the results of psychometric analyses and tests of concurrent and predictive validity.

Instrument	Internal consistency	Measurement invariance	Acceptable model fit	Behavioral delay	Task completion strategy
MBP	*Y*	*Y*	*N*	*Y*	*N*
AFP	*Y*	*Y*	*N*	*Y**	*N*
GPS	*Y*	*Y*	*N*	*N*	*N*
AIP	*Y*	*Y*	*N*	*Y**	*N*
APS	*Y*	*Y*	*N*	*N*	*N*
UPS	*Y*	*Y*	*Y*	*Y**	*N*
PASS	*Y*	*Y*	*N*	*Y*	*N*
IPS	*Y*	*Y*	*Y*	*Y*	*N*
PPS	*Y*	*Y*	*N*	*N*	*N*
TPS	*Y*	*Y*	*Y*	*Y*	*N*

Asterisks denote weak predictive effects. Given the poor fit of many of the self-report measures, the results of the measurement invariance analyses for the poor-fitting models should be interpreted with caution.

are in their best interests (Silver and Sabini, 1981; Steel, 2007, 2010). Some research suggests that this irrationality becomes clearer in hindsight (Kahneman and Tversky, 1981; Denes-Raj and Epstein, 1994). This form of bias is widely referred to as secondary hindsight bias (Kelman et al., 1998; Fischhoff, 2003), whereby a person revises their initial estimate of an event's occurrence to align with an observed outcome. In the case of procrastination, a student may initially underestimate the likelihood that they will procrastinate on a term paper at the beginning of the semester. When asked about their academic habits at the end of the semester, the student upwards adjusts their estimate and acknowledges themselves as a procrastinator. What's more, the student wrongfully believes that they would have described themselves as a procrastinator at the beginning of the semester. Although this belief contradicts the student's earlier report, it results from updating estimates and certainty in light of new information (Kelman et al., 1998; Malatincová, 2015). Future research could test for secondary hindsight bias by administering questionnaires at task assignment and follow-up.

This perspective on irrationality aligns with definitions provided by the field of decision science wherein irrationality is something that can unfold—knowingly or unknowingly—as a byproduct of environmental, cognitive/perceptual, and personal constraints (Brunswik, 1943). Information about the rewards and consequences of task completion is not always available (c.f., Stevens, 1957), nor are the probabilities of success always known (Hau et al., 2010). For example, at the beginning of the semester, students are often unaware of how a final paper assignment will impact their grade. As the student completes and receives grades on assignments, they gain awareness of the paper's impact and their abilities in the class. A student who is failing would have to expend effort to pass the class with a C+ paper; a student who has made straight A's all semester may still receive an A even if they fail to turn the paper in. Indeed, factors such as these can impact the accuracy of a person's self-referential judgments (e.g., Funder, 2012). For some students, the effort (Mitchell, 2017) and delayed rewards associated with the final paper may seem less attractive than the more immediate benefits of replying to an email or enjoying a game of Dungeons and Dragons with friends (Ainslie, 1975). Individual differences such as these are of particular importance in task completion decisions, which require a person to integrate and assign value to information across several domains (Kurzban et al., 2013) and windows of time (Grund and Fries, 2018).

This perspective could explain the divergence in our results whereby some self-report measures of procrastination could predict days to study completion, but none of the self-report measures predicted students' pacing styles. Students who participated in our research study at the beginning of the semester might have misestimated the degree to which they would procrastinate at the end of the semester. This would produce an alignment between their self-report scores and their completion date and a divergence between self-report scores and their pacing style. There is some evidence for this perspective in studies that involve self-reports of dilatory behavior (e.g., Rothblum et al., 1986; Lay and Burns, 1991; Neo and Skoric, 2009; Lubbers et al., 2010; Malatincová, 2015; Liborius et al., 2019); however, the results of this study suggest that it is worthwhile to explore this effect further using objective single-index measures of delay.

Relatedly, it is useful to note that perceptions of procrastination may depend on the reference task (Vangsness and Young, 2020). For example, a student may have delayed their research participation so that they could study for their midterm exams. This student may self-report procrastination when thinking about their research participation, but not when thinking about their exam preparation. This line of reasoning could also explain the lack of relationship between self-reported procrastination and pacing style.

Pacing Style and Procrastination May Be Unrelated Constructs

Many researchers and practitioners define procrastination as a conscious behavior (e.g., Pychyl and Flett, 2012; Chowdhury and Pychyl, 2018) that differs from unintentional or strategic forms of delay (e.g., Chu and Choi, 2005; Choi and Moran, 2009) in three key ways. First, a person must indicate their intention to procrastinate on a task. That is, the delay is goal-oriented rather than a means to an end. Second, this delay must be unnecessary or irrational. Third, the delay must result in negative consequences (Klingsieck, 2013). By this narrow definition, a

student who delays studying to work on tomorrow's homework assignment is not engaging in procrastination. Although the delay is intentional and may result in a negative outcome (i.e., poor test performance), it is a necessary consequence of wanting to perform better on the homework assignment. That isn't to say this student hasn't procrastinated at all—perhaps they delayed working on the homework assignment, despite their knowledge of the long-term consequences regarding their ability to study for their exam. Rather, this example illustrates an important point: only some delay is classified as procrastination.

Framed differently, procrastination represents a behavioral subset of the deadline action pacing style, which is characterized by increases in task engagement prior to a deadline. Given the relationship between the two constructs, researchers expected there to be a positive correlation between a person's self-reported procrastination and engagement in the deadline action pacing style (Gevers et al., 2015). That is, everyone who self-reports procrastination should exhibit a deadline action pacing style, whereas only some people who exhibit deadline action pacing should endorse procrastination. This relationship was not observed in our study. One possible explanation is that pacing style and procrastination are not related constructs. This seems unlikely, given that delay is a defining feature of both procrastination and deadline action pacing. An alternative perspective is that one or both constructs are poorly defined.

Although a debate regarding the conceptual definitions of either construct is beyond the scope of this psychometrics paper, we acknowledge that this explanation would partially fit the pattern of results observed here. We observed that participants who endorsed statements relating to procrastination exhibited characteristic delays in research study completion but not in their overall patterns of research credit completion. Therefore, we recommend that future research address the competing hypotheses outlined here and give clarity to the conceptual definitions of procrastination and pacing styles.

Some Self-Report Measures May Not Adequately Capture Procrastination

Another potential explanation for why self-report measures did not always predict behavior may have to do with the measures themselves. For instance, the results of our confirmatory factor analyses (CFA) and measure invariance (MI) tests indicated that certain scales (e.g., UPS IPS, PPS, TPS) displayed much better psychometric properties than other scales (e.g., MBP, AIP, APS). Consequently, it is possible that certain scales simply do a poor job of assessing procrastination, suffer from various validity issues (e.g., poorly written items, items that are unrelated to the underlying construct, etc.), and, therefore, are unable to predict meaningful outcomes (e.g., behavioral delay). Indeed, even the most well-validated personality scales can be laden with validity issues (Hussey and Hughes, 2020). Thus, it is crucial for researchers to ensure they are using appropriate measures when assessing procrastination. Only when measurement issues are eliminated as a potential explanation for the low self-report/behavioral delay linkage can more substantive explanations be properly evaluated.

Limitations and Specificity of Findings

Finally, it is important to note that our findings are not without their limitations. We assessed procrastination in a specific context—research participation on a college campus—and it is possible that this is a domain for which some of the self-report instruments we elected to study are ill-designed. We also assessed procrastination at a single institution of higher education. While it is fair to say that our data indicate that respondents behaved similarly to those we have assessed at other institutions, it is possible that these findings may not generalize to other areas of the country or the world.

We also conducted our assessments on a subset of the many self-report and derivative instruments that are available to researchers today. While it is unlikely for single-item or subset items to perform better than a complete survey instrument (Ock, 2020), some researchers do use them. Additionally, some researchers recommend using refined, short-form instruments that assess a single dimension of the latent construct (e.g., the PPS, Svartdal and Steel, 2017; the GPS, Klein et al., 2019). We did not include these *ad hoc* or short-form assessments in our study. Given the evidence presented in this paper, we recommend that future research include such measures.

It is also worth noting that this study took place during the start of the COVID-19 pandemic. Although our behavioral measure of students' pacing styles yielded results similar to those observed before the pandemic (Vangsness and Young, 2020; Voss and Vangsness, 2020), the overall proportion of students engaging in deadline action pacing was slightly higher (24% in this sample vs. 19% in Vangsness and Young, 2020). Future research might consider how external events impact students' pacing styles and their self-reports of procrastination.

CONCLUSION

Most of the instruments we included in our assessment were validated using tests of Cronbach's alpha, exploratory factor analysis, and CFA. However, few instruments underwent tests of MI or predictive validity prior to their widespread use. The APA notes that "evidence of internal structure provides empirical support for the construct. . . it does not in and of itself establish [predictive validity], which requires additional evidence" tying scores to behavioral outcomes (Sackett et al., 2018). In our study, certain self-report instruments failed to meet these criteria (i.e., GPS, APS, PPS, AFP, AIP, UPS). Given these results—and those observed elsewhere (e.g., PASS, Yockey and Kralowec, 2015; APS, Pinxten et al., 2019)—we recommend that researchers cautiously employ these scales, especially when the goal is to predict behavioral delay within academic contexts. This may simply entail ensuring the scales have acceptable psychometric properties in the research context in which they are used and being transparent about any instances where appropriate psychometric properties are not obtained.

We do believe these results can be informative for future studies on the construct validity of these scales and for better understanding why certain procrastination measures display more/fewer construct validity issues than others. We also found that self-report measures were not predictive of students' pacing styles. While it is possible that task completion strategies are not a viable measure of procrastination behavior, it is also possible that memory biases undermine participants' reports of procrastination. Moving forward, we also recommend that future research be conducted to determine which of these hypotheses is correct.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/r7wcx/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Wichita State University IRB. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LV and NV jointly conceptualized the research idea. LV conducted and oversaw the investigation, conducted inter-item reliability, correlational, cluster, and predictive analyses, and was the curator of the OSF database where the study's data files and supplementary materials are housed. VD and EM developed the study materials under the supervision of LV. NV conducted MI and CFA tests. LV, NV, and NM conducted the subsequent review and editing. All authors jointly prepared the original draft.

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How Did You Sleep Tonight? The Relevance of Sleep Quality and Sleep–Wake Rhythm for Procrastination at Work

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Recent studies have highlighted the relevance of sleep for procrastination at work. Procrastination at work is defined as the irrational delay of the initiation or completion of work-related activities. In line with recent studies, we offer a self-regulation perspective on procrastination. We argue that procrastination is an outcome of depleted self-regulatory resources and that the restoration of self-regulatory resources during high-quality sleep at night would prevent procrastination.

Aims: In an attempt to further develop this line of research, the current study aimed to achieve a broader understanding of the relevance of sleep and circadian rhythm for procrastination. Therefore, we explored the effect of sleep quality on procrastination for different chronotypes. We also considered the shift to daylight saving time as a phenomenon that aggravates circadian misalignment and thereby later chronotypes' dependence on high-quality sleep. Specifically, we hypothesized that compared to employees with an earlier chronotype (morning types), employees with a later chronotype (evening types) are more dependent on good sleep at night to prevent procrastination the next day. This effect would be especially pronounced after the shift to daylight saving time.

Methods: For this repeated-measures study, participants were 101 full-time employees. They completed a general questionnaire and day-specific questionnaires on the Monday before and the Monday following the shift to daylight saving time.

Results: The multilevel analyses showed that employees procrastinated less on days following nights during which they slept better and that later chronotypes experienced more procrastination than earlier chronotypes. Our findings also supported the hypothesis that the relationship between sleep quality and procrastination is stronger for later chronotypes compared to earlier chronotypes on the Monday following the shift to daylight saving time. In other words, the lower the sleep quality of later chronotypes during the previous night, the more they procrastinated on the Monday following the shift to daylight saving time.

Discussion: Our findings further corroborate the existing findings on the relevance of sleep and chronotype for well-being and performance at work.

Keywords: procrastination, sleep quality, chronotype, summer time, shift to daylight saving time, self-regulation

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INTRODUCTION

"Never put off till tomorrow what you can do the day after tomorrow." This quote by Mark Twain addresses the phenomenon of procrastination. Procrastination is defined as the tendency to delay the initiation or the completion of activities (Lay, 1986; Howell et al., 2006; Steel, 2007). According to Steel (2007), procrastination reflects an intention–behavior gap. Specifically, people "intend... to do something, but put... it off despite expecting that it will yield negative consequences" (Kühnel et al., 2018b). Procrastination carries the risk of detrimental consequences at work, including strain and poor performance (Steel, 2007; Kim and Seo, 2015), failure to meet deadlines (van Eerde, 2003), risking the success of projects (Gersick, 1989), problems in social relationships (Küchler et al., 2019), and lost productivity (Stead et al., 2010; Beutel et al., 2016).

From the theoretical perspective of self-regulation, procrastination is considered an indicator of failed self-regulation (Ferrari, 2001; Kühnel et al., 2016; van Eerde, 2016). Self-regulation covers the autonomous regulation of goal-directed behavior, which includes adapting thoughts, feelings, desires and actions to personally relevant goals (Ridder and Wit, 2006; Vohs and Baumeister, 2011; Kühnel et al., 2016). Self-regulatory resources are necessary for individuals to regulate and initiate action at work. When an individual has low self-regulatory resources, focus on work tasks is difficult to maintain, and the individual will be more likely to choose pleasurable alternatives. In other words, when self-regulatory resources are low, the individual's action initiation is impeded and procrastination occurs (Tice and Baumeister, 1997). Therefore, restoring self-regulatory resources during non-work periods is a prerequisite for an individual's ability to initiate action at work (Kazén et al., 2008; Kühnel and Sonnentag, 2011).

An important non-work period during which self-regulatory resources can be restored is sleep. Recent studies have shed light on the relevance of day-specific sleep quality and people's preferred sleep–wake rhythm (chronotype) for procrastination at work. In line with Baumeister et al.'s (2000) work, Kühnel et al. (2016) showed that high-quality sleep at night restores self-regulatory resources, thereby preventing procrastination the next day. The research into procrastination at work, as well as its relationship with sleep at night, has recently begun to gain attention. To gain further insights into this relationship and contribute to this stream of research, this study aimed to achieve a broad understanding of the relevance of sleep and circadian rhythm for procrastination. This led to three specific aims. First, we sought to replicate the negative relationship between sleep quality and procrastination. Second, we aimed to clarify the role of individually-preferred sleep–wake rhythms in the relationship between sleep and procrastination, and thereby answer the question of whether some people are more dependent on good-quality sleep than others. Third, we focused on the shift to daylight saving time (DST) as a potential promoter of procrastination. The shift to DST is a phenomenon that should aggravate circadian misalignment, and thereby, later chronotypes' dependence on high–quality sleep (Marcus and Schuler, 2004). **Figure 1** demonstrates the conceptual model for this study and summarizes the hypotheses we derived from the theoretical perspective of self-regulation.

Sleep Quality and Procrastination

All activities that require self-regulation draw on a resource that is not infinite (Baumeister et al., 1998). When one's self-regulatory resources are depleted (Marcus and Schuler, 2004), it becomes more difficult to resist dysfunctional or impulsive actions, and procrastination may occur. Recovery, meanwhile, which is characterized by replenishment of the resources necessary for self-regulation (Binnewies et al., 2009), should counteract the occurrence of procrastination. Sleep is a recovery process that ensures restoration of resources that are necessary for self-regulatory functioning the next day (e.g., Baumeister et al., 2000; Barber et al., 2010). Barnes et al.'s (2011) research emphasized the role of sleep *quality*, stating that it provides an important foundation for an individual's self-regulation ability. According to Barnes et al. (2011) poor sleep minimizes and high-quality sleep maximizes self-regulatory resources. This is in line with previous studies showing that high-quality sleep at night restores self-regulatory resources and thus prevents procrastination the next day (Kühnel et al., 2016). Therefore, we assume that people will procrastinate less after nights characterized by better sleep quality compared to nights characterized by lower sleep quality. Consequently, the first hypothesis of this study is that day-specific sleep quality negatively predicts procrastination the next day.

Chronotype and Procrastination

Our study aimed to address the question of whether some people are more dependent on good-quality sleep to prevent procrastination than others. Studies have highlighted that interindividual differences in biologically preferred sleep–wake rhythm (chronotype) are associated with self-regulation and therefore play a role in procrastination (Díaz-Morales et al., 2008; Digdon and Howell, 2008; Hagger, 2010). The individual characteristic chronotype is normally distributed in the population (Roenneberg et al., 2003). Earlier chronotypes (morning types, or "larks")—who prefer to go to sleep earlier in the evening and wake up earlier in the morning—sit at one end of the continuum. Meanwhile, later chronotypes (evening types, or "owls")—who prefer to go to sleep later in the evening and wake up later in the morning—sit at the other end of the continuum. The majority are located in the middle of the continuum (intermediate chronotypes). Interindividual differences in sleep–wake rhythm arise from the interplay of genetic influences and environmental factors (Hur and Lykken, 1998; Vink et al., 2001). The most important environmental factor is sunlight, which is used by an individual's endogenous circadian clock to entrain to the individual's environment and control the daily physiological (sleep–wake) rhythm across 24 h (Roenneberg et al., 2003; Kantermann et al., 2007; Wagner et al., 2012). Studies have demonstrated that melatonin levels occurring in the blood and activity levels peak at different times of the day, depending on whether participants are earlier chronotypes (earlier peaks) or later chronotypes (later peaks) (Mongrain et al., 2004; Vitale et al., 2015). Due to early work and school start times, later chronotypes particularly have to adapt their sleep–wake times to meet social

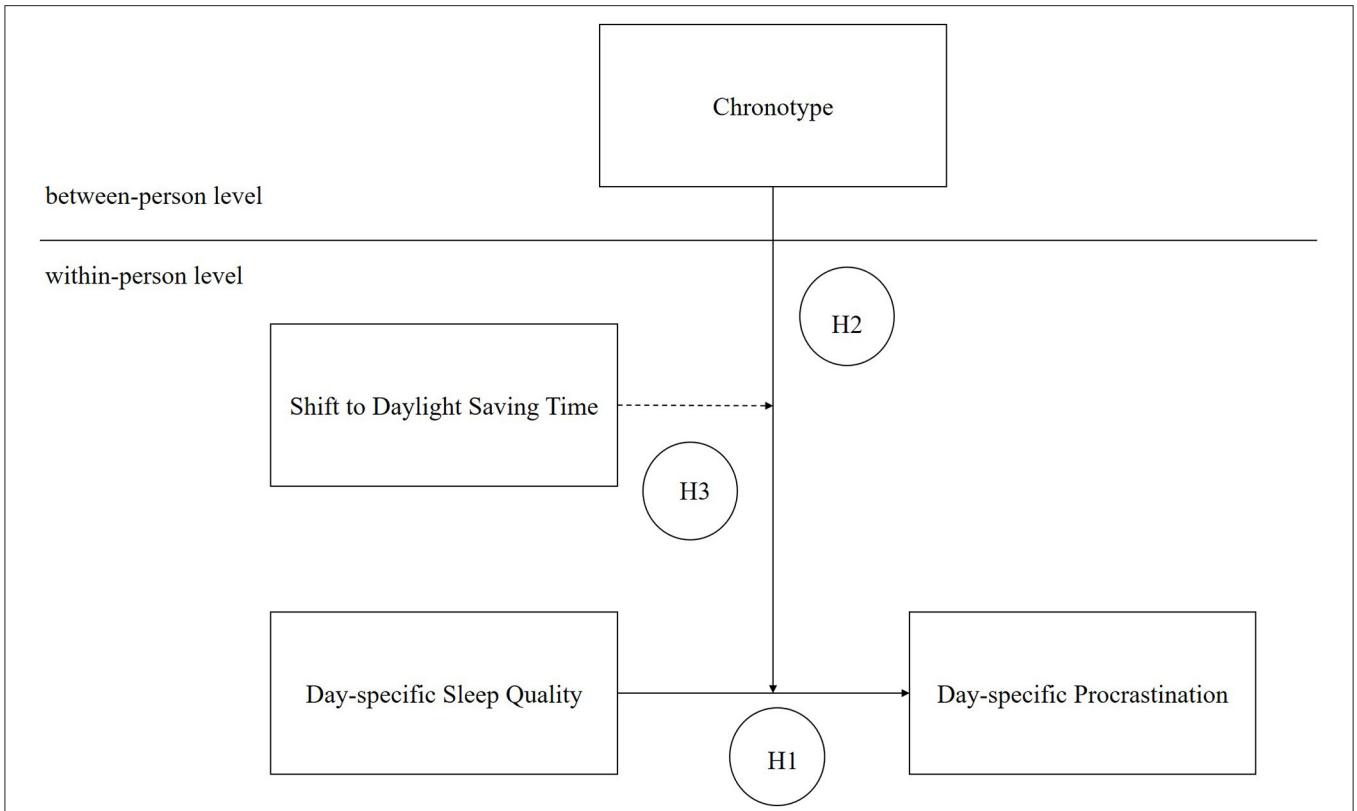

FIGURE 1 | Conceptual model of the current study. Within-person variance (Level-1 variance) captures the variation in variables from day to day within persons and between-person variance (Level-2 variance) captures the variation in variables between persons.

obligations. Specifically, later chronotypes are required to wake up on schedule, even though they still need to sleep (Kühnel et al., 2016). As a result, later chronotypes' actual sleep–wake times and their biologically preferred sleep–wake times diverge, causing a circadian misalignment (Wittmann et al., 2006). Consequently, later chronotypes need more self-regulatory resources to manage everyday life activities, as they are more likely to be compelled to live against their biological rhythm, which requires greater self-regulatory efforts daily (Kühnel et al., 2018b).

We argue that circadian misalignment would make later chronotypes especially dependent on high-quality sleep. Indeed, Schmidt et al. (2007) and Guarana et al. (2021) summarized and integrated the findings on sleep's role in "inhibit[ing] impulses and overcoming temptations"—an important aspect of self-regulation. They concluded that in this context, individuals' chronotypes should be considered an important variable of interindividual difference. Kühnel et al.'s (2016) findings are in line with this idea; they reported that people who experience a greater circadian misalignment (compared to people who experience less circadian misalignment) procrastinate more the next day when their sleep quality during the night is low. These findings suggest that some people need more resources for self-regulation in everyday life; therefore, they tend to be more dependent on good-quality sleep (Kühnel et al., 2016). Taken together, we propose that later chronotypes, compared to earlier chronotypes, are more dependent on good-quality sleep at night to prevent procrastination at work. Therefore, the second hypothesis of this study is that the chronotype moderates the negative relationship between day-specific sleep quality and procrastination the next day. This negative relationship is stronger for later chronotypes (evening types) compared to earlier chronotypes (morning types).

Shift to DST, Sleep–Wake Rhythm, and Procrastination

Later chronotypes' greater dependence on good-quality sleep would be even more pronounced under challenging environmental circumstances that aggravate their circadian misalignment. Once a year, many countries around the world switch from standard to summer time (DST) on the last Sunday in March, when the local clock time is set to 1 hour later. The shift to DST means local clock time will be, for example, 3:00 a.m. (DST) instead of 2:00 a.m. (standard time). Kantermann et al. (2007) showed that the entrainment of an individual's endogenous circadian clock to the individual's environment is disrupted by the shift to DST, as the circadian clock is synchronized with the "sun clock" (day/light–night/dark–cycle), which does not change. Given that an individual's circadian clock does not adjust to the new local clock time, but social obligations such as work and school start times follow the

new local clock time, the shift to DST potentially induces and/or aggravates a mismatch (circadian misalignment) between individuals' preferred sleep–wake rhythms (chronotype) and their actual sleep–wake times. This should especially be the case for later chronotypes compared to earlier chronotypes, as local clock time is advanced and thus in contrast to what later chronotypes would prefer (Kantermann et al., 2007; Lahti et al., 2008; Allebrandt et al., 2014). We argue that the shift to DST aggravates circadian misalignment, which increases the need for self-regulatory resources, especially for later chronotypes (Kantermann et al., 2007; Kühnel et al., 2018b). The increased need for self-regulatory resources results in later chronotypes depending even more on sleep quality and its replenishing effect (Wagner et al., 2012; Kühnel et al., 2018b), to prevent procrastination the next day (Kühnel et al., 2016). In other words, the shift to DST would increase later chronotypes' dependence on good-quality sleep to prevent procrastination the next day. Accordingly, we propose the third hypothesis for this study: the shift to DST increases later chronotypes' dependence on good-quality sleep, to prevent procrastination the next day. Following the shift to DST (compared to before the shift to DST), later chronotypes are even more dependent on good-quality sleep to prevent procrastination the next day. In technical terms, the chronotype and shift to DST jointly moderate the relationship between day-specific sleep quality and procrastination the next day.

METHODS

Sample and Procedure

One hundred and one full-time employees from companies in diverse industries across different regions in Germany participated in this repeated-measures study. Data were collected by one of the co-authors as part of her master's thesis. Sixty-seven individuals from the convenience sample were women, and the participants' age ranged from 20 to 66 years (Mean age = 48 years; $SD = 9$). Participants had about ∼10 years of professional experience in their current organization, and they worked 40.24 h on average per week. Blue-collar jobs (with mainly physical work) were represented at 28.7%, while 64.2% of the participants mainly did office work (so-called white-collar jobs).

Only non-shift workers and employees who worked at least 30 h per week were requested to participate. To motivate employees to participate in the study, we offered participants individual evaluations of their chronotypes, as well as feedback based on the results of the study. All employees who provided informed consent to participate received a paper-and-pencil questionnaire booklet by mail. First, they completed a general questionnaire (**t0**) before the working week starting with Monday, 23rd of March about their sociodemographic characteristics and chronotype. Then, they were asked to answer identical questionnaires on the Monday, 23rd of March before (**t1**) and the Monday, 30th of March following (**t2**) the shift to DST (shift from Saturday, 28th of March to Sunday, 29th of March). At each survey point, the participants were advised to answer the questions immediately after their workday; they were also reminded by e-mail or *via* SMS to answer the questionnaires at the given time. Following the completion of the entire questionnaire booklet, the participants were requested to return the booklets by mail (free of charge).

Of the 157 questionnaires that were mailed to the participants, 130 were returned (82%). Due to incomplete responses (e.g., answering only one of the day-specific questionnaires or failing to complete the general questionnaire) and participants not completing the questionnaires at the instructed time (e.g., belatedly completing the questionnaire booklet all at once), data from 22 participants were excluded. In addition, seven participants were excluded due to externally determined sleep hours on days off, which is one of the exclusion criteria of the Munich Chronotype Questionnaire (MCTQ, see Measures Section). The final sample comprised 101 employees (completion rate: 64%).

Measures

General Questionnaire (t0)

Chronotype

We used the MCTQ (Roenneberg et al., 2003) to assess the participants' chronotypes. The MCTQ assesses the responder's typical sleep times on workdays and work-free days based on their sleep onset and sleep offset (separately for workdays and work-free days). The MCTQ chronotype is determined by calculating the midpoint between sleep onset and offset on free days (including a correction to balance an increased need for sleep due to the accumulated sleep deficit during the workweek) (Roenneberg et al., 2012). Higher values indicate a later chronotype—that is, a later midpoint of sleep on work-free days. For example, if a person's sleep onset on work-free days is at 1:00 a.m. and sleep offset is at 11:00 a.m., the midpoint of sleep on work-free days is at 6:00 a.m.; therefore, the person's chronotype value would be six. For individuals who do not report *unrestricted* sleep times on work-free days, biologically preferred sleep–wake rhythm (chronotype) cannot be calculated with the MCTQ. Exclusion criteria are when respondents use an alarm to wake up on work-free days, or when their naturally occurring sleep on work-free days is prematurely terminated (externally) because of small children or pets requiring attention.

Day-Specific Questionnaires on the Monday Before (t1) and the Monday After (t2) the Shift to DST

Sleep Quality

We used a single item derived from the Pittsburgh Sleep Quality Index (Buysse et al., 1989) to assess day-specific sleep quality (i.e., "How do you evaluate this night's sleep?"). This item has been used successfully in studies assessing day-specific sleep in the morning (Sonnentag et al., 2008; Hülsheger et al., 2015). Participants rate their overall sleep quality on a 5-point Likert-type scale (ranging from 1 = very poor to 5 = excellent).

Procrastination

Day-specific procrastination was assessed using six items from the Tuckman Procrastination Scale (Tuckman, 1991) that were slightly modified to assess day-specific procrastination (Kühnel et al., 2016). Example items are "Today, I needlessly delayed finishing jobs, even when they were important." and "Today, I

promised myself I will do something and then dragged my feet." The participants' responses were recorded on a 5-point Likert-type scale (ranging from 1 = strongly disagree to 5 = strongly agree). Cronbach's alpha was 0.83 and 0.81 on Monday before the shift to DST (t1) and on Monday after the shift to DST (t2), respectively.

Statistical Analysis

We used Mplus 8.4 to conduct multilevel analyses, which account for the nested data structure. The nested data structure arises by measuring the variables sleep quality and procrastination more than once, and thus, they exhibit within-person variation (Level 1: within-person level) and between-person variation (Level 2: between-person level). To test our hypotheses, we examined sleep quality as a predictor of procrastination (Hypothesis 1), the joint effect of sleep quality and chronotype as a predictor of procrastination (Hypothesis 2), and chronotype and the effect of "time" (before vs. after the shift to DST) as joint moderators of the relationship between sleep quality and procrastination (Hypothesis 3). The predictor variable "time" is a within-person variable that refers to the two time points that were coded 0 = *Monday before the shift to DST [t1]* and 1 = *Monday after the shift to DST [t2]*. Thus, the predictor variable time depicts intraindividual differences between the Monday before and the Monday after the shift to DST in the dependent variable. Following best practice recommendations by Aguinis et al. (2013) to test cross-level interaction effects, the within-person level variable sleep quality was person-mean centered for all analyses, while the person-level predictor variable chronotype was grand-mean centered.

To predict day-specific procrastination, we specified and compared several nested hierarchical models. In Model 1, we entered the within-person level predictor variable "sleep quality" (Hypothesis 1). In Model 2 we included the person-level predictor variable "chronotype" and a random slope of sleep quality predicting procrastination. The random slope models allow the relationship between sleep quality and procrastination to vary between persons. Model 3, which tested Hypothesis 2, included the interaction term between chronotype and sleep quality as a predictor of procrastination. In technical terms, chronotype was modeled as a predictor of the random slope of sleep quality predicting procrastination; thus, chronotype is a cross-level moderator. In other words, Model 3 tests whether chronotype explains variance in the strength of the relationship between sleep quality and procrastination. Model 4 contained all of the two-way interactions between the predictor variables time, sleep quality, and chronotype predicting procrastination. Model 5 included the three-way interaction between sleep quality, time, and chronotype (Hypothesis 3). In technical terms, chronotype was modeled as a predictor of the random slope of sleep quality × time predicting procrastination.

RESULTS

Descriptive Statistics

Table 1 depicts the means, standard deviations, intercorrelations between variables, and intraclass correlation coefficients based on our analyses. We calculated the variance proportions using null models for each day-specific variable. Fifty-nine percent and 91% of the variance of the specific variables procrastination and sleep quality resided on the within-person level, respectively.

The within-person correlation between the day-specific variables procrastination and sleep quality (above the diagonal in **Table 1**) was significant and negative ($r = -0.25$, $p < 0.001$). To calculate the within-person correlation, the day-specific variables were person-mean centered. The between-person correlations (below the diagonal in **Table 1**) indicate that procrastination was positively related to chronotype ($r = 0.33$, $p < 0.01$), negatively related to age ($r = -0.28$, $p < 0.01$), and not significantly related to gender ($r = 0.00$, $p = 0.99$). Chronotype was negatively related to age ($r = -0.46$, $p < 0.001$). **Table 2** presents the nested models.

Test of Hypothesis 1: The Relationship Between Sleep Quality and Procrastination

Model 1 shows that sleep quality at night significantly and negatively predicted procrastination the next day (estimate = −0.103, $SE = 0.039$, $t = -2.63$, $p < 0.01$). Thus, Hypothesis 1 was confirmed; employees procrastinate less on days following nights during which they sleep better.

TABLE 1 | Means, standard deviations, and correlations of variables.

Variable	*M*	*SD*	1-ICC[b]	1	2	3	4	5
1. Day-specific procrastination	1.34	0.42	0.59	–	−0.25***	0.10		
2. Day-specific sleep quality	3.26	0.73	0.91	−0.19	–	−0.23**		
3. Time[a] (before vs. after the shift to DST)	0.50	0.50	1.00	–	–	–		
4. Chronotype	3.45	0.97	–	0.33**	−0.03	–	–	
5. Age	41.94	13.08	–	−0.28**	0.10	–	−0.46***	–
6. Gender[c]	0.66	0.48	–	0.00	−0.06	–	−0.05	−0.03

*[a]0 = Monday before the shift to DST; 1 = Monday after the shift to DST. Correlations above the diagonal are day-level (within-person) correlations (N = 202). Correlations below the diagonal are person-level (between-person) correlations. To obtain person-level correlations, day-level data were aggregated (N = 101). To obtain day-level correlations, procrastination and sleep quality were centered around the respective person-mean. [b]Intraclass correlation (ICC) = ratio of the between-person variance to the total variance, 1-ICC = ratio of the within-person variance to the total variance. [c]Gender: 1 = female, 0 = male. **p < 0.01, ***p < 0.001.*

TABLE 2 | Results of multilevel analyses predicting day-specific procrastination.

	Null model			Model 1			Model 2		
	Est	***SE***	***t***	**Est**	***SE***	***t***	**Est**	***SE***	***t***
Intercept	1.344	0.042	32.20***	1.344	0.042	32.20***	1.344	0.039	34.45***
Sleep quality				−0.103	0.039	−2.63**	−0.101	0.040	−2.38*
Time (before vs. after the shift to DST)[a]									
Sleep quality × Time[a]									
Level 2 predictor									
Chronotype							0.153	0.040	3.82***
Cross-Level interactions									
Sleep quality × Chronotype									
Time[a] × Chronotype									
Sleep quality × Time[a] × Chronotype									
−2 × log likelihood		274.506 (3)			267.840 (4)			254.334 (6)	
Δ −2 × log likelihood (*df*)					6.667 (1)**			13.506 (2)***	
Level 1 intercept variance (*SE*)		0.148 (0.021)			0.138 (0.019)			0.136 (0.025)	
Level 2 intercept variance (*SE*)		0.102 (0.027)			0.107 (0.027)			0.086 (0.025)	
Level 2 slope variance (*SE*)—time[a]									
Level 2 slope variance (*SE*)—sleep quality								0.003 (0.023)	
Level 2 slope variance (*SE*)—Sleep quality × Time[a]									

	Model 3			Model 4			Model 5		
	Est	***SE***	***t***	**Est**	***SE***	***t***	**Est**	***SE***	***t***
Intercept	1.344	0.039	34.46***	1.325	0.045	29.32***	1.323	0.044	30.11***
Sleep quality	−0.099	0.044	−2.22*	−0.044	0.066	−0.66	−0.051	0.063	−0.82
Time (before vs. after the shift to DST)[a]				0.021	0.048	0.44	0.021	0.048	0.43
Sleep quality × Time[a]				−0.079	0.122	−0.80	−0.087	0.116	−0.75
Level 2 predictor									
Chronotype	0.153	0.040	3.82***	0.208	0.048	4.29***	0.162	0.049	3.32**
Cross-level interactions									
Sleep quality × Chronotype	−0.043	0.036	−1.20	−0.069	0.044	−1.56	0.064	0.063	1.024
Time[a] × Chronotype				−0.117	0.054	−2.16*	−0.119	0.053	−2.24*
Sleep quality × Time[a] × Chronotype							−0.282	0.112	−2.51*
−2 × log likelihood		252.756 (7)			247.650 (12)			241.662 (13)	
Δ −2 × log likelihood (*df*)		1.578 (1)			5.086 (5)			6.008 (1)*	
Level 1 intercept variance (*SE*)		0.135 (0.028)			0.126 (0.025)			0.128 (0.027)	
Level 2 intercept variance (*SE*)		0.086 (0.026)			0.086 (0.023)			0.078 (0.023)	
Level 2 slope variance (*SE*)—time[a]					0.003 (0.047)			0.003 (0.045)	
Level 2 slope variance (*SE*)—sleep quality		0.002 (0.033)			0.001 (0.024)			0.001 (0.034)	
Level 2 slope variance (*SE*)—Sleep quality × Time[a]					0.017 (0.051)			0.006 (0.046)	

*Est = Estimate; [a]0 = Monday before the shift to DST; 1 = Monday after the shift to DST. *p < 0.05, **p < 0.01, ***p < 0.001.*

Test of Hypothesis 2: The Moderating Effect of Chronotype on the Relationship Between Sleep Quality and Procrastination

Model 3 tested whether employees with later chronotypes (evening types) were more dependent on good-quality sleep at night to prevent procrastination the next day compared to earlier chronotypes (morning types). Model 2 shows that chronotype significantly predicted procrastination (estimate = 0.153, SE = 0.040, t = 3.82, $p < 0.001$). There was no significant effect of chronotype as a cross-level moderator on the relationship between sleep quality and procrastination in Model 3 (estimate = −0.043, $SE = 0.036$, $t = -1.20$, $p = 0.167$). Thus, Hypothesis 2 was rejected.

Test of Hypothesis 3: The Joint Effect of Chronotype, Time (Before vs. After the Shift to DST), and Sleep Quality Predicting Procrastination

Finally, we used Model 5 to examine whether the shift to DST increases later chronotypes' dependence on good sleep quality to

prevent procrastination the next day. The three-way interaction between time, sleep quality, and chronotype was significant (estimate = −0.282, *SE* = 0.112, *t* = −2.51, *p* < 0.05), and Model 5 fit the data better than the previous model (Δ −2 × log likelihood = 6.008, *df* = 1, *p* < 0.05). We conducted simple slope analyses with Preacher et al.'s (2006) online-based computational tool. We examined the relationship between sleep quality and procrastination for later (+ 1 *SD*) vs. earlier (−1 *SD*) chronotypes for before and after the shift to DST. The simple slope of sleep quality predicting procrastination was significant for later chronotypes after the shift to DST (simple slope = −0.35, *SE* = 0.09, *t* = −3.82, *p* < 0.001). Simple slopes of sleep quality predicting procrastination were not significant for later chronotypes before the shift to DST (simple slope = 0.01, *SE* = 0.08, *t* = 0.15, *p* = 0.88), for earlier chronotypes before the shift to DST (simple slope = −0.11, *SE* = 0.10, *t* = −1.15, *p* = 0.25), or for earlier chronotypes after the shift to DST (simple slope = 0.07, *SE* = 0.12, *t* = 0.62, *p* = 0.53). In other words, the relationship between sleep quality and procrastination was negative for later chronotypes only on the Monday following the shift to DST. **Figure 2** demonstrates this relationship. Put another way, only later chronotypes were dependent on good-quality sleep to prevent procrastination on the Monday following the shift to DST. Hence, our findings partially supported Hypothesis 3.

DISCUSSION

The current study examined the effects of sleep and chronotype on procrastination at work. Moreover, this study considered the effect of the shift to DST as a phenomenon manipulating employees' required sleep–wake times in their everyday work life. We found that day-specific sleep quality predicted procrastination the next day. That is, a lower sleep quality during the night resulted in more procrastination the next day. Further, later chronotypes (evening types) experienced more procrastination than did earlier chronotypes (morning types). Our study's results did not confirm our hypothesis that for later chronotypes compared to earlier chronotypes, sleep quality is more important for procrastination the next day. Our analyses showed that the expected pattern occurred only after the shift to DST. More precisely, after the shift to DST, later chronotypes reported more procrastination during the day when they experienced low-quality sleep the previous night.

Taken together, the results of this study extend the findings on procrastination by providing more insight into the conditions under which procrastination is more likely to occur. We gained a better understanding of the relationship between sleep and procrastination by clarifying the role of chronotype. Furthermore, we identified the shift to DST as a condition that influences different chronotypes' likelihood of procrastination. This study is the first to shed light on the effect of the interplay of sleep quality, chronotype, and the shift to DST on procrastination.

Sleep Quality and Procrastination

The findings of this study are in line with previous findings that highlight the relevance of sleep for self-regulatory resources to initiate action at work (Baumeister et al., 1998; Kühnel et al., 2016). In particular, we could replicate previous studies' results, showing that on days following nights during which employees had slept better, they procrastinated less (Kühnel et al., 2016). During sleep, the replenishment of the self-regulatory resources is ensured (Baumeister et al., 2000; Barber et al., 2010), but if their replenishment is hampered because of low-quality sleep, people have more difficulties resisting dysfunctional or impulsive actions, and procrastination can occur. Our results underscore the usefulness of the theoretical perspective of self-regulation to understand and predict procrastination. Particularly, sleep quality is a prerequisite to ensure employees' ability to initiate action at work.

Chronotype and Procrastination

We clarified the role of individually-preferred sleep–wake rhythm (chronotypes) in the relationship between sleep and procrastination. In line with other studies (Díaz-Morales et al., 2008; Digdon and Howell, 2008), our findings showed that later chronotypes procrastinated more than earlier chronotypes. This finding supports our theoretical assumption that later chronotypes may require more resources for self-regulation in everyday life, and consequently, they may be more prone to procrastination in general. Adapting sleep–wake times to their work schedules and coping with one's circadian misalignment (Wittmann et al., 2006) could be possible reasons for later chronotypes needing more self-regulatory resources. Guarana et al. (2021) emphasized the relevance of chronotype and circadian effects in sleep research, as individually-preferred sleep–wake rhythms have been shown to influence impulse inhibition or overcoming temptation. To understand this effect in greater detail, future studies may investigate mechanisms underlying the relationship between chronotype and procrastination.

However, the results did not reveal any differences between chronotypes regarding the importance of sleep quality for procrastination. In our study, there was no difference between chronotypes in their degree of dependence on good-quality sleep. One might speculate that the later chronotypes in our sample might have successfully developed strategies to cope with the increased demands for self-regulation in their daily life. One might also question our assumption that later chronotypes experienced more circadian misalignment in their daily life. It is possible that the later chronotypes in our sample had later and/or flexible work start times and no other social obligations because of which they were less affected by circadian misalignment and thus not more dependent on good-quality sleep compared to earlier chronotypes. Another explanation for our findings is that the distribution of chronotypes in our sample was restricted compared to the distribution of chronotypes in the population. Specifically, earlier chronotypes were considerably overrepresented in our sample, which may have mirrored the reality of earlier and intermediate chronotypes rather than the reality of later chronotypes.

DST, Chronotype, and Procrastination

Finally, we found that the shift to DST aggravates later chronotypes' dependence on high-quality sleep to prevent

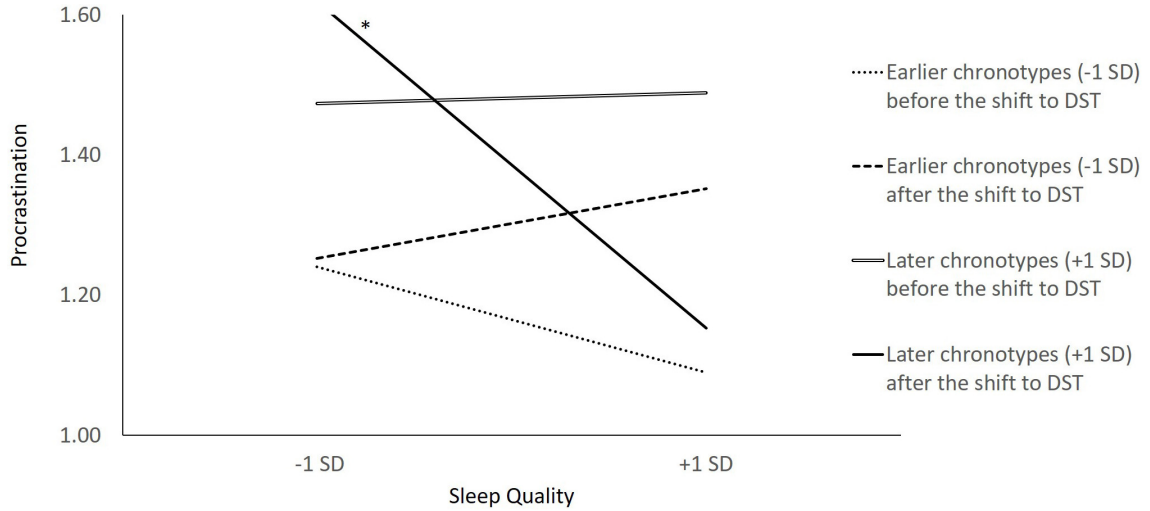

FIGURE 2 | Relationship between day-specific sleep quality and procrastination for earlier (−1 *SD*) vs. later (+1 *SD*) chronotypes before vs. after the shift to daylight saving time.

procrastination the next day (Culić and Kantermann, 2021). Our findings thus reveal the consequences of the shift to DST, especially for later chronotypes. In particular, our results are thus in line with previous studies, showing the greater dependence of later chronotypes on sleep quality and its replenishing effect (Kühnel et al., 2016; Przepiórka et al., 2019). Regarding procrastination, earlier chronotypes were unaffected by the shift to DST. Our findings support the idea, that a circadian misalignment leads to increased demands for self-regulation in daily life (Kühnel et al., 2018b), and therefore, a greater need for replenishing the resources needed for self-regulation.

Limitations and Suggestions for Future Research

Later chronotypes were underrepresented in this study's sample, which may have resulted in an underestimation of the true effect of chronotype on the relationship between sleep quality and procrastination at work. Future studies may want to employ a different recruiting strategy to achieve an unrestricted distribution of chronotypes. This may be challenging, however, as especially late chronotypes may refrain from filling in questionnaires immediately after the shift to DST.

The relationship between sleep quality and procrastination might be overestimated due to concurrent measurement of both variables. Yet, studies which assessed sleep quality and procrastination separated in time (sleep quality in the morning and procrastination at the end of the work day; sleep quality before the shift and procrastination at the end of the shift) found within-person correlations between sleep quality and procrastination that were of similar size as the within-person correlation we found [$r = -0.19$ in Kühnel et al. (2018a); $r = -0.22$ in Kühnel et al. (2016); $r = -0.25$ in the current study], mitigating concerns that the relationship found is solely due or strongly inflated due to concurrent measurement.

Measuring self-regulatory resources would allow to explicitly test our theoretical assumption that greater circadian misalignment increases the need for self-regulatory resources, especially for later chronotypes, to prevent self-regulatory failure. Assessing self-regulatory resources would allow researchers to investigate whether dealing with the shift to DST—and thus dealing with circadian misalignment—depletes self-regulatory resources. Future research should examine self-regulatory resources using questionnaires and/or other approaches that assess the availability of self-regulatory resources such as the Stroop test (Kuhl and Kazén, 1999).

A comparison between countries that shift to DST would also be an interesting topic for future research. A question arises whether the current findings are generalizable to other countries that shift from the standard time to DST, or whether this effect is mitigated in countries with a napping culture (i.e., Spanish *siesta*), such as Spain.

Further, the effect of the shift from DST to standard time in autumn may also be an interesting research direction. Researchers could investigate whether later chronotypes, who experience negative effects of the shift to DST, have greater benefits when shifting to standard time. Such studies would provide valuable insights into the consequences of a *reduction* of misalignment, as well as its potential benefits for different chronotypes.

At last, a study with a follow-up design would further extend our findings. In particular, it would be useful to investigate whether the effects of the shift to DST reduce soon after the shift to DST or whether they last longer, maybe even throughout the DST period. A previous study has shown that chronotypes differ in terms of how soon they adapt to DST (Kantermann et al., 2007)—later chronotypes may take longer to adapt to the new local clock time.

Practical Implications

The results of our study offer ways to reduce procrastination, specifically concerning sleep quality and the shift to DST. Various researchers, including Guarana et al. (2021), Kühnel et al. (2021), Ohayon et al. (2017), and Schmidt et al. (2007) have offered relevant recommendations for improving sleep quality. They propose educational and behavioral approaches, as well as employing influential behaviors by authority figures and role models (Kühnel et al., 2021). Moreover, organizations should also become role models in this regard. One useful approach for organizations is to offer individually-adjustable working hours for different chronotypes to foster good sleep. A trend toward concepts like flex time has already emerged in recent years. Additionally, leaders can foster their employees' sleep by communicating its importance; they can also demonstrate it by taking care of their own sleep.

It is important to consider that later chronotypes in particular not only experience the negative effects of typical work time schedules but also are more affected by the shift to DST. A chronotype-specific training to promote healthy sleep practices and sleep hygiene should be offered at least once a year—ideally, immediately before the shift to DST.

Finally, our findings contribute to the debate around whether DST should be abolished. Existing evidence indicates that the shift to DST does not offer energy-saving benefits (e.g., Aries and Newsham, 2008; Roenneberg et al., 2019), and our results suggest that doing away with the shift to DST could eliminate adverse consequences for later chronotypes.

DATA AVAILABILITY STATEMENT

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

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

JK and BZ made substantial contributions to the conception and design of the study. BZ collected the data. TM and JK analyzed and interpreted the data and drafted the manuscript and revised the manuscript for important intellectual content. All authors contributed to the article and approved the submitted version.

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Procrastination Among University Students: Differentiating Severe Cases in Need of Support From Less Severe Cases

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Procrastination refers to voluntarily postponing an intended course of action despite expecting to be worse off for this delay, and students are considered to be especially negatively affected. According to estimates in the literature, at least half of the students believe procrastination impacts their academic achievements and well-being. As of yet, evidence-based ideas on how to differentiate severe from less severe cases of procrastination in this population do not exist, but are important in order to identify those students in need of support. The current study recruited participants from different universities in Sweden to participate in an anonymous online survey investigating self-rated levels of procrastination, impulsivity, perfectionism, anxiety, depression, stress, and quality of life. Furthermore, diagnostic criteria for pathological delay (PDC) as well as self-report items and open-ended questions were used to determine the severity of their procrastination and its associated physical and psychological issues. In total, 732 participants completed the survey. A median-split on the Pure Procrastination Scale (PPS) and the responses to the PDC were used to differentiate two groups; "less severe procrastination" (PPS $\leq$ 2.99; n = 344; 67.7% female; M age = 30.03; SD age = 9.35), and "severe procrastination" (PPS $\geq$ 3.00; n = 388; 66.2% female; M age = 27.76; SD age = 7.08). For participants in the severe group, 96–97% considered procrastination to a problem, compared to 42–48% in the less severe group. The two groups also differed with regard to considering seeking help for procrastination, 35–38% compared to 5–7%. Participants in the severe group also reported more problems of procrastination in different life domains, greater symptoms of psychological issues, and lower quality of life. A thematic analysis of the responses on what physical issues were related to procrastination revealed that these were characterized by stress and anxiety, e.g., tension, pain, and sleep and rest, while the psychological issues were related to stress and anxiety, but also depression, e.g., self-criticism, remorse, and self-esteem. The current study recommends the PPS to be used as an initial screening tool, while the PDC can more accurately determine the severity level of procrastination for a specific individual.

Keywords: procrastination, students, assessment, severity, differentiation

INTRODUCTION

In academia, procrastination is a well-known, almost commonplace phenomenon. Students often delay tasks and activities inherent to learning and studying, despite knowing that they will be worse off because of the delay (cf. Steel, 2007; Steel and Klingsieck, 2016). For some students, academic procrastination can be specific to a situation (i.e., state procrastination), for others it takes on features of a habit or a disposition (i.e., trait procrastination). Studies estimate that almost all students engage in procrastination once in a while, while 75% consider themselves habitual procrastinators (Steel, 2007). For almost half of these habitual procrastinators, procrastination is a real and persistent problem (Steel, 2007), and something they would like to tackle (Grunschel and Schopenhauer, 2015). It can be assumed, however, that not all of them seek help due to the self-regulative problems inherent to procrastination, and, even more so, due to feelings of shame associated with procrastination (Giguère et al., 2016).

In light of the negative consequences, procrastination can have for academic achievement (e.g., Kim and Seo, 2015), and well-being (cf. Sirios and Pychyl, 2016), it seems important to screen for cases of severe procrastination in a student population in order to offer the support needed. In the case of students who do seek help in student health centers, it is also helpful to see whether they represent a case of severe or less severe procrastination so that support can be tailored to their specific needs.

The aim of the current study is, thus, to differentiate between students who might be in need of professional help from those with less pressing concerns. This is done by determining what characterizes severe and less severe procrastinators with regard to their level of anxiety, depression, stress, quality of life, impulsivity, perfectionism, and demographic variables. Procrastination itself is also assessed by two different self-report measures with the intention of proposing ways of screening in a student population. This could help therapists identify those in need of guidance so that effective interventions can be introduced. For college and university students this would be particularly useful as they find themselves in a setting where procrastination is particularly endemic, often lack the necessary resources or strategies to overcome problems on their own, and procrastination can have dire consequences not only for their academic achievements but also physical and psychological well-being.

CONCEPTUAL FRAMEWORK

Academic Procrastination

The prominent definition of procrastination as "to voluntarily delay an intended course of action despite expecting to be worse off for the delay" (Steel, 2007, p. 66) reflects two important aspects of the phenomenon. First, procrastination is a post-decisional phenomenon in goal-directed behavior in that an intention (e.g., to study for an exam) has been formed. Second, procrastination is acratic in nature since individuals put of the intended course of action contrary to knowing better. This acratic nature is reflected by feelings such as regret, shame, guilt, worry, and anxiety (e.g., Giguère et al., 2016). It is important to acknowledge that a delay is not procrastination if it is strategic or results from causes not under the control of the individual (cf. Klingsieck, 2013). Taking these aspects – post-decisional, acratic, and non-strategic – together, suggests that procrastination is a failure in self-regulation (cf. Steel, 2007), This is the most popular conceptualization of procrastination in the literature. In fact, the dispositional, the motivational-volitional, the clinical, and the situational perspective on procrastination can be boiled down to this understanding of procrastination (Klingsieck, 2013). As for students, while academic procrastination is just a little nuisance for some, it entails serious problems for others.

Procrastination's Link to Depression, Anxiety, Stress, and Quality of Life

Procrastination is associated with negative consequences concerning performance as well as physical and psychological well-being. However, although never a particularly helpful behavior, the relationship with performance is probably not as strong as most would expect. Among students, the correlation with academic achievement is weak, *r*s = −0.13 to −0.19 (Steel, 2007; Kim and Seo, 2015), and perhaps not the main reason for why individuals regard procrastination as a problem. Instead, it might be its effects on physical and psychological well-being that eventually makes someone seek professional help (Rozental and Carlbring, 2014). In a qualitative study of 36 students, for instance, the most frequently reported negative consequences were anger, anxiety, feelings of discomfort, shame, sadness, feeling remorse, mental stress, and negative self-concept (Grunschel et al., 2013). Systematic reviews and meta-analyses on the link between procrastination and symptoms of psychiatric conditions have also found a weak but nonetheless clinically meaningful correlation with depression, *r*s = 0.28 to 0.30 (van Eerde, 2003; Steel, 2007). The same also goes for anxiety, $r = 0.22$ (van Eerde, 2003). Studies investigating the connection between self-report measures in different populations have demonstrated stronger correlations, such as Rozental et al. (2015) in a clinical trial of adults seeking treatment for procrastination ($n = 710$), $r = 0.35$ for depression and $r = 0.42$ for anxiety. Similar results were also obtained by Beutel et al. (2016) in an adult community sample ($n = 2527$), $r = 0.36$ for depression and $r = 0.32$ for anxiety. Although both lower mood and increased unrest can, in themselves, cause procrastination, it is assumed that procrastination also creates a downward spiral characterized by negative thoughts and feelings (Rozental and Carlbring, 2014).

Apart from depression and anxiety, students generally tend to regard procrastination as something stressful. Stead et al. (2010) investigated this association using self-report measures in a sample of students ($n = 200$), demonstrating a weak but nonetheless significant correlation between procrastination and stress, $r = 0.20$. Similar findings were reported by Sirois et al. (2003) for students ($n = 122$), and Sirois (2007) for a sample of community-dwelling adults ($n = 254$), *r*s = 0.13 to 0.20. Further, Beutel et al. (2016) found somewhat stronger correlations with stress, $r = 0.39$, as well as with burnout, $r = 0.27$. Stress might also

play a role as mediator between procrastination and illness, as proposed by the so-called procrastination-health model by Sirois (2007), implying that procrastination not only leads to more stress, but that the increase in stress in turn leads to many physical issues. Meanwhile, in terms of quality of life and satisfaction with life, procrastination exhibits a weak negative correlation, $r = -0.32$ (Rozental et al., 2014), and $r = -0.35$ (Beutel et al., 2016), meaning that procrastination could take its toll on how one appreciates current circumstances.

However, despite the fact that procrastination might be affecting physical and psychological well-being negatively, it is still unclear when it goes from being a more routine form of postponement to becoming something that warrants support, for instance in the realm of counseling or therapy. The literature suggests that as many as 20% of the adult population could be regarded as "chronic procrastinators" (Harriot and Ferrari, 1996, p. 611), a number that is easily surpassed by the 32% of students that were characterized as "severe, general procrastinators" (Day et al., 2000, p. 126). Students are generally considered worse-off when it comes to recurrently and problematically delaying important curricular activities, with more than half of this population stating that they would like to reduce their procrastination (Solomon and Rothblum, 1984). Still, all of these rates rely on arbitrary cutoffs on specific self-report measures, such as exceeding a certain score, or do not define what is meant by procrastination, which may not correspond to something that requires clinical attention (Rozental and Carlbring, 2014). Establishing a more valid cutoff is therefore needed in order to separate the less severe cases of procrastination from those having problems to the degree that it severely affects everyday life.

Procrastination's Link to Impulsivity and Perfectionism

Two other variables that are frequently explored in relation to procrastination involve impulsivity and perfectionism. These might be especially pertinent to examine in the context of students who, due to their age, are more impulsive and engage in more reckless behaviors, such as binge drinking (Lannoy et al., 2017), but also tend to perceive the relentless pursuit of high standards as socially desirable despite the fact it can become maladaptive (Stoeber and Hotham, 2013). Research has found that impulsivity is moderately correlated with procrastination, $r = 0.41$ (Steel, 2007), making it one of the strongest predictors among the personality traits. A twin study by Gustavson et al. (2014) confirmed this association ($n = 663$), suggesting that the genetic correlation between impulsivity and procrastination is perfect, $r = 1.0$. However, this was later questioned by a twin study with a much larger sample ($n = 2012$), demonstrating a weak but nonetheless noteworthy correlation, $r = 0.29$ (Loehlin and Martin, 2014). Rozental et al. (2014) also examined the link between impulsivity and procrastination, but using a self-report measure of susceptibility to temptation, indicating a moderate correlation, $r = 0.53$. At its core, impulsivity shares many features with procrastination (i.e., self-regulatory failure), making it reasonable to expect a strong connection between the two constructs. Meanwhile, the relationship between perfectionism and procrastination has been disputed. Originally, Steel (2007) demonstrated a non-significant correlation, $r = -0.03$. Similarly, the correlation by van Eerde (2003) was weak, $r = 0.12$. This goes against the clinical impression by many therapists that perfectionism often leads to procrastination. However, in both of these cases perfectionism was perceived as a unidimensional construct. There is currently consensus that perfectionism in fact has two higher-order dimensions; (1) perfectionistic strivings, i.e., setting high standards and expecting no less than perfection from yourself, and (2) perfectionistic concerns, i.e., being highly self-critical and overly concerned about others' perception of you, and having a hard time enjoying your achievements. A recent systematic review and meta-analysis separating these two demonstrated a more complex relationship with procrastination (Sirois et al., 2017). Perfectionistic strivings had a weak negative correlation with procrastination, $r = -0.22$, while perfectionistic concerns had a weak positive correlation with procrastination, $r = 0.23$. In other words, setting and striving for high standards might actually be associated with less procrastination, while the more neurotic aspects of perfectionism are related to more procrastination.

To what extent impulsivity and perfectionism might differ between cases of less severe and severe cases of procrastination is currently unknown. However, just as physical and psychological well-being is expected to be more negatively affected among those who exhibit higher levels of procrastination, impulsivity and perfectionism should be more pronounced.

The Current Study

The aim of the current study is to investigate all of these aspects in a sample of students with the purpose of trying to differentiate between those who might be in need for professional help from those with less pressing matters. The idea is to outline their respective characteristics with regard to scores on self-report measures on anxiety, depression, stress, quality of life, impulsivity, and perfectionism, and demographics. Procrastination itself is assessed by two different self-report measures. This first measure is the Pure Procrastination Scale (PPS; Steel, 2010) which is a widely used self-report measure. The second measure are the recently proposed diagnostic criteria for pathological delay (Pathological Delay Criteria; PDC; Höcker et al., 2017).

The second aim of the current study is to explore the physical and psychological issues related to procrastination on a deeper level. This is made possible through a qualitatively analysis of the responses to two open-ended questions regarding the impact of recurrently putting off activities that need to be completed. Prior research has by qualitative means primarily studied the antecedents of procrastination (Klingsieck et al., 2013), but rarely its implications for physical and psychological well-being. One notable exception is the interview study by Grunschel et al. (2013) cited in the introduction. Investigating these experiences in detail and how often they occur could provide a better understanding of how procrastination affects someone physically and psychologically, and in turn when further assistance might be necessary.

MATERIALS AND METHODS

Procedure

The study received ethical approval from the Swedish Ethical Review Authority in June 2020 (Dnr: 2020-00555). Advertisements for the study were initially sent out in October 2020 via the communications office of Karolinska Institutet, which is a medical university in Stockholm, Sweden. However, in order to recruit students from other backgrounds, information about the study was also forwarded to two additional universities in Sweden and posted on various student forums on Facebook, LinkedIn, Accindi, and Instagram. Using a link to a website created specifically for the study, the student could then read about the research aims and design, procedures for data collection and management, ethics, and the principal investigator. The student was also informed that a 45-min pre-recorded lecture with the first author on procrastination would follow once the survey was completed, as a small token of gratitude for the student's participation. After submitting informed consent, the student was forwarded to an anonymous survey managed through Limesurvey. Both, the website and the survey itself, were available in Swedish and English. The whole survey took on average 21 min for the participants to complete (*SD* = 16 min), and always followed the same order of presentation, i.e., no randomization of self-report measures or items were made. Every item of a self-report measure had to be completed to progress to the next, presenting only one self-report measure per page and using a progress bar on top of the screen to convey how much was left on the survey.

Sample

In total, 806 students decided to open the link and 797 actually started filling out the survey, resulting in 732 complete survey responses (90.8%). There were no systematic differences between completers and non-completers concerning their demographic information and procrastination, with the exception of civil status (see **Appendix** for the specifics). Of those who finished the survey, 66.6% were female, which corresponds with the most recent numbers on the gender distribution of newly admitted university students in Sweden (58% female; Swedish Higher Education Authority, 2020). The mean age was 28.8 years (*SD* = 8.30; range 18–65). They were either single (44%) or married (54%), and the vast majority had no children (78%). In terms of their education, 6.8% attended just a single course, (e.g., Nutrition, the nutrients, and metabolism, 7.5 higher education credits), 63.7% underwent a complete study program, such as the study program in dental hygiene (180 higher education credits), 9.1% were enrolled in post graduate studies, for example the study program in psychotherapy (90 higher education credits), and 3.4% were admitted as doctoral candidates. Of note, 30 higher education credits correspond to one semester full-time. The participants had, on average, achieved 195 higher education credits (*SD* = 141), which thus corresponds to 3.25 years of full-time education. With regard to psychiatric disorders, 115 self-reported having a diagnosis (15.7%). These were grouped according to the responses to an open-ended question, with mixed conditions representing the largest category (40%, i.e., having more than one diagnosis, mostly a combination of depression and anxiety), followed by depression (13.9%), and ADHD (13%). As for questions regarding procrastination, 71% considered it to be a problem, with a mean age of 17.5 years (*SD* = 5.7; range 10–53) for when they first started perceiving it as problematic, and 29.4% of this group had considered seeking help for procrastination. None of these variables differed between genders, see **Table 1** for an overview.

Instruments

Procrastination

In order to differentiate and classify the more severe cases of procrastination, a widely used self-report measure is applied, the Pure Procrastination Scale (PPS), which was originally introduced and validated by Steel (2010), and translated to a large number of languages since (Svartdal et al., 2016). The PPS was developed from several other self-report measures, retaining only those items that demonstrated the strongest factor loadings on the core construct of procrastination (i.e., not other forms of delay), hence the name "pure." The PPS has 12 items, e.g., "I often find myself performing tasks that I had intended to do days before" (item 6), is scored according to a 5-point Likert-scale (1–5), and has an internal consistency in the current study of Cronbach's $\alpha = 0.92$.

Secondly, diagnostic criteria for pathological delay (Pathological Delay Criteria; PDC), which were put forward in a therapy manual by Höcker et al. (2017), are also used to differentiate between less and more severe cases of procrastination. According to the PDC, procrastination can be considered pathological if the following two criteria are met:

Over the past 6 months. . .

(1) On at least half of the days, important tasks were delayed past the adequate point in time, even though there was sufficient time to complete them.
(2) Procrastination has strongly interfered with reaching personally relevant goals.

In addition, at least three of following criteria also need to be fulfilled:

(1) More than half of the time available for completing a task was wasted by procrastinating.
(2) On at least half of the days, other less important tasks were preferred, even though the individual wanted to start working on the more pressing tasks.
(3) On at least half of the days, the delay caused aversion and animosity.
(4) At least half of the tasks that were to be completed were finished only under great time pressure or not at all due to procrastination.
(5) At least half of the individual's performance potential was impaired due to procrastination.
(6) The individual has experienced physical issues due to procrastination (e.g., tensed muscles, sleeping disorders, cardiovascular problems, gastric, and digestive problems), or psychological issues due to procrastination (e.g.,

TABLE 1 | Descriptive statistics for whole sample and results of *t*-tests of gender differences.

	Whole sample (*N* = 732)				Female (*n* = 488)		Male (*n* = 241)					
	M	*SD*	*Min*	*Max*	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*	*d*
Age	28.83	8.30	18	65	29.40	8.89	27.72	6.85	2.80	600.54	0.01	0.20
Education Credits	194.99	140.85			196.34	137.67	192.00	146.44	0.39	723.00	0.70	0.03
Age Start Procrastination	17.53	5.74	10	53	17.79	5.98	17.11	5.29	1.25	486.00	0.21	0.12
Pure Procrastination Scale (PPS)	3.00	0.91	1.00	5.00	2.96	0.92	3.07	0.89	1.50	727	0.13	0.12
Effects of Procrastination on Life-Domains												
Interests/leisure	4.68	2.940	0.00	10.00	4.90	2.90	4.25	2.99	2.41	512	0.02	0.22
Work/studies	7.76	1.923	0.00	10.00	7.75	1.95	7.78	1.89	2.41	512	0.02	0.02
Friendships/social life	4.50	2.801	0.00	10.00	4.57	2.72	4.38	2.95	0.76	512	0.45	0.07
Community/engagement/spirituality	3.09	3.192	0.00	10.00	3.21	3.24	2.86	3.11	1.16	512	0.25	0.11
Family life/parenting	3.71	2.810	0.00	10.00	3.91	2.84	3.39	2.74	1.99	512	0.05	0.18
Rest/sleep	6.36	2.992	0.00	10.00	6.50	3.00	6.04	2.96	1.67	512	0.10	0.15
Love/intimate relationships	3.79	3.179	0.00	10.00	3.71	3.07	3.97	3.37	0.86	347.223	0.39	0.08
Physical activity/diet	6.02	2.930	0.00	10.00	6.33	2.84	5.43	3.01	3.37	512	0.00*	0.31
Susceptibility to Temptation Scale (STTS)	3.15	0.93	1.00	5.00	3.11	0.94	3.24	0.91	1.78	727	0.08	0.14
Clinical Perfectionism Questionnaire (CPQ)												
CPQ_Personal Standards	2.66	0.63	1.00	4.00	2.74	0.60	2.49	0.65	5.01	441.77	0.00*	0.41
CPQ_Emotional Concerns	2.93	0.76	1.00	4.00	3.00	0.72	2.78	0.81	3.61	429.22	0.00*	0.30
Generalized Anxiety Disorder Questionnaire (GAD-7)	7.85	5.59	0.00	21.00	8.36	5.72	6.79	5.20	3.71	521.32	0.00*	0.28
Patient Health Questionnaire (PHQ-9)	8.95	6.34	0.00	27.00	9.12	6.35	8.54	6.24	1.16	727	0.25	0.09
Perceived Stress Scale (PSS)	2.91	0.65	1.14	4.71	2.78	0.59	2.66	0.61	2.61	727	0.01	0.21
Brunnsviken Brief Quality of Life Scale (BBQ)												
BBQ_Leisure time	7.87	4.81	0.00	16.00	7.87	4.76	7.88	4.92	−0.03	727	0.98	0.02
BBQ_View of Life	9.68	5.14	0.00	16.00	9.88	5.08	9.32	5.22	1.39	727	0.17	0.11
BBQ_Creativity	6.83	5.12	0.00	16.00	6.91	5.14	6.60	5.04	0.77	727	0.44	0.06
BBQ_Learning	9.61	5.03	0.00	16.00	9.83	4.99	9.20	5.11	1.61	727	0.11	0.13
BBQ_Friends	9.76	5.32	0.00	16.00	10.06	5.35	9.15	5.23	2.16	727	0.03	0.17
BBQ_Self	8.70	5.04	0.00	16.00	8.86	4.99	8.44	5.11	1.07	727	0.29	0.08
BBQ_Total	52.46	21.21	0.00	96.00	53.41	21.01	50.58	21.62	1.68	466.01	0.09	0.13

*$p < 0.002$ (Bonferroni correction); Calculations based on sum scores for GAD-7, PHQ-9, and BBQ.

restlessness, feeling of being pressured, feeling of being helpless, inner tension, and anxiety).*

* At least five of these issues need to be reported to meet this criterium.

The criteria above were developed as a diagnostic instrument for differential diagnosis and as a basis for clinical decision making. During its development, the authors followed the definition and structure of psychiatric disorders used by the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013). In order to select the criteria with the best predictive value, large samples of university students seeking help at a procrastination clinic at the University of Münster, Germany, were used (e.g., Engberding et al., 2011). The authors used the methods of best subset regression and ROC-analyses to select the criteria with the highest scores on sensitivity and specificity for identifying pathological delay. These criteria and the corresponding questionnaire were subsequently published in the therapist manual (Höcker et al., 2017).

Further variables of meaningful aspects concerning procrastination were assessed: (1) if the participant itself believes procrastination is a problem and, if yes, (2) at what age the participant started perceiving procrastination as a problem, (3) if the participant has ever considered seeking help for procrastination, and (4) the impact of procrastination on various life domains. In order to assess how procrastination had affected the participants, its negative effects on eight different life domains were probed for: "To what degree do you think procrastination has affected you negatively in the following life domains?". The life domains were: interest/leisure, work/studies, friendships/social life, community/engagement/spirituality, family life/parenting, rest/sleep, love/intimate relationships, and physical activity/diet. Participants rated each life domain using a 10-point Likert-scale ranging from 0 = not at all to 10 = very much. The life domains were inspired by the type of value measures often used in Acceptance and Commitment Therapy (Reilly et al., 2019), and are commonly employed in many clinical trials (e.g., Buhrman et al., 2020; Ehlers et al., 2020).

Impulsivity

Impulsivity was assessed using the Susceptibility to Temptation Scale (STS; Steel, 2010; Svartdal et al., 2016), which is comprised of 11 items regarding the inclination to fall for more immediate

gratifications, e.g., "I will crave a pleasurable diversion so sharply that I find it increasingly hard to stay on track" (item 1). The STS is scored on a 5-point Likert-scale (1–5), and has an internal consistency in the current study of $\alpha = 0.93$.

Perfectionism

Perfectionism was assessed by the Clinical Perfectionism Questionnaire (Dickie et al., 2012). This scale assesses the frequency of dysfunctional self-imposed standards in the last 4 weeks by a subscale covering the personal standards (i.e., perfectionistic standards), and a second subscale covering emotional concerns and consequences (i.e., perfectionistic concerns). Item 9 of the original scale ("Have you repeatedly checked how well you are doing at meeting your standards [for example, by comparing your performance with that of others]?") was omitted because it did not load on the factor perfectionistic standards as in the original version by the authors. Item 2 of the subscale perfectionistic concerns ("Have you tended to focus on what you have achieved, rather than on what you have not achieved?") was omitted due to a very low item-scale-correlation. Thus, the subscale Personal Standards (CPQ_PS) was composed of five items (α in current study = 0.71; sample item "Have you been told that your standards are too high?"). The subscale Emotional Concerns (CPQ_EC) was composed of three items (α in current study = 0.76; sample item "Have you been afraid that you might not reach your standards?"). The CPQ is scored on a four-point Likert-scale (1–4).

Anxiety

Anxiety was examined using the Generalized Anxiety Disorder – 7 Items (GAD-7; Spitzer et al., 2006). It consists of seven items concerning the general level of anxiety and worry experienced during the last 2 weeks, and is often used as a screening tool for anxiety disorders, e.g., "Over the last 2 weeks, how often have you been bothered by the following problems: Worrying too much about different thing" (item 3). The GAD-7 is scored on a four-point Likert-scale (0–3), and has an internal consistency in the current study of $\alpha = 0.90$. A score of 5 points indicate mild anxiety, 10 moderate anxiety, and 15 severe anxiety.

Depression

Depression was assessed by the Patient Health Questionnaire – 9 Items (PHQ-9; Kroenke et al., 2001). It has nine items on depressive symptoms experienced during the last 2 weeks, in accordance with the diagnostic criteria for major depressive disorder (American Psychiatric Association, 2013), e.g., "Over the last 2 weeks, how often have you been bothered by any of the following problems? Little interest or pleasure in doing things" (item 1). The PHQ-9 is scored on a four-point Likert-scale (0–3), and has an internal consistency in the current study of $\alpha = 0.88$. A score of 5 points indicate mild depression, 10 moderate depression, 15 moderately severe depression, and 20 severe depression.

Stress

Stress was explored using the Perceived Stress Scale (PSS; Cohen et al., 1983). It is comprised of 14 items regarding stress in different situations, as experienced during the last month, e.g., "In the last month, how often have you felt that you were unable to control important things in your life?" (Item 2). The PSS is scored on a five-point Likert-scale (1–5), and has an internal consistency in the current study of $\alpha = 0.85$.

Quality of Life

Quality of life was determined by the Brunnsviken Brief Quality of Life Scale (BBQ; Lindner et al., 2016). It features six life domains (leisure time, view of one's own life, learning, creativity, friends and friendship, yourself as a person), and is rated on both importance and how satisfied one is with each domain, e.g., "I am satisfied with my leisure time; I have the opportunity to do what I want in order to relax and enjoy myself." (domain 1). The BBQ is scored on a 5-point Likert-scale (0–4), where importance and satisfaction in each domain are multiplied and summing the products for a total score (range 0–96). These weighted ratings as well as the total score for quality of life was used for the current study. The BBQ has an internal consistency of $\alpha = 0.79$ in the current study.

In addition, achieved higher education credits was assessed to differentiate the two groups by their academic achievement. Age and gender were assessed as demographic variables but only used to characterize the sample and not to differentiate the groups.

Quantitative Analysis

Multiple *t*-tests and Chi^2-tests were performed by SPSS Version 27. The significance level was corrected (Bonferroni) to $p < 0.002$ (*t*-tests) and 0.007 (Chi^2-Tests). In order to differentiate severe cases from less severe cases of procrastination, the sample was split along the median (*Med.* = 3.00) of the PPS. This created two groups, which are referred to as: "less severe procrastination" (PPS $\leq$ 2.99; $n = 344$; 67.7% female; $M_{age} = 30.03$; $SD_{age} = 9.35$), and "severe procrastination" (PPS $\geq$ 3.00; $n = 388$; 66.2% female; $M_{age} = 27.76$; $SD_{age} = 7.08$). For the second differentiation, the PDC was used to split the sample into the corresponding groups (i.e., based on whether the participants fulfilled all of the necessary criteria or not): "less severe procrastination" ($n = 398$; 71.5% female; $M_{age} = 29.94$; $SD_{age} = 9.03$), and "severe procrastination" ($n = 344$; 61.6% female; $M_{age} = 27.51$; $SD_{age} = 7.11$).

Qualitative Analysis

Two items of the PDC were open-ended and therefore analyzed qualitatively. Given the nature of these variables and their manifest content, that is, being short text-based survey responses with little room for elaboration, inductive thematic analysis was deemed appropriate to use. Inductive refers to generating a new understanding of the subject matter, rather than testing a predefined theoretical framework during the analysis (Thomas, 2006). Meanwhile, thematic analysis is a procedure for qualitative analysis considered suitable for exploring recurrent patterns or themes within data. Braun and Clark (2006) provide an overview of the steps in the analytic process, which usually includes familiarizing yourself with your data by reading it repeatedly and taking notes, extracting meaningful entities of relevance to the purpose of the study, generating codes representing important issues for further inquiry, collating the codes to

explore potential themes, reviewing the themes by going back and forward to your data, naming the themes, and reporting and discussing the results. The first author conducted the thematic analysis and discussed the results with the last author, but no further attempt at cross-validation was considered necessary given the characteristics of the data. The first author is a Swedish clinical psychologist and researcher with extensive experience of treating and researching procrastination, perfectionism, anxiety disorders, and exhaustion disorder, and has worked with both quantitative and qualitative methods.

The first qualitative item of the PDC concerned the physical issues of procrastination and involved a dataset of 2304 words (the average number of characters per response was 59.8, *SD* = 92.7). The second qualitative item of the PDC concerned the psychological issues of procrastination and was comprised of 4022 words (the average number of characters per response was 55.8, *SD* = 67.5). Because of a high degree of overlap in the responses, such as a vast majority reporting experiencing anxiety regardless of being a severe procrastinator or not, and that each response could entail a large number of physical as well as psychological issues, the variables could only be analyzed and presented qualitatively, rather than being part of the quantitative analysis.

RESULTS

Descriptive Statistics

Table 1 presents the descriptive statistics for each self-report measure as well as their respective gender differences (female vs. male). There were only statistically significant gender differences on the CPQ (Cohen's *d* = 0.30 and 0.41), and GAD-7 (*d* = 0.28), with female students scoring higher than male students. As for procrastination, the average score was 3.00 (*SD* = 0.91), which is the same as the median split used for grouping the participants into severe and less severe procrastinators, while 46% of the sample fulfilled the PDC criteria. Negative effects of procrastination were most prominent in the life domains of work/studies, physical activity/diet, and rest/sleep, and being considerably lower in the life domains of family life/parenting and community/engagement/spirituality. The average scores on the GAD-7 and PHQ-9 correspond to mild anxiety and mild depression.

Differentiating Severe Cases From Less Severe Cases of Procrastination

The results of differentiating severe cases from less severe cases of procrastination are presented in detail in **Tables 2–4**. The two groups diverged with regard to their perception of procrastination. In the group "severe procrastination," almost every participant (96–97%) considered procrastination to be a problem, while those participants belonging to the group "less severe procrastination" did so to a much lesser extent (42–48%). In addition, 35–38% of the severe procrastinators had considered seeking help for their problems, compared to just 5–7% among the less severe procrastinators. There were also statistically significant differences with regard to the negative impact of procrastination on different life domains between the two groups, especially work/studies, *d* = 1.20–1.23.

With the exception of perfectionism scores, severe cases and less severe cases of procrastination differed on all of the self-report measures, with severe procrastinators scoring higher on all measures and lower on quality of life. Moreover, the participants in the group "severe procrastination" also had a higher proportion of psychiatric disorders, and met the criteria for moderate and severe anxiety, and moderate and severe depression. From a demographic perspective, participants with severe procrastination were generally older and had achieved fewer higher education credits. When using the PPS to differentiate the groups, there were no gender differences. However, based on the PDC, the portion of female participants with severe procrastination was significantly lower than the portion of females in the group of less severe procrastination.

Differential Overlap

Based on a median split on the PPS, 53% of the participants were considered to be severe procrastinators while applying the PDC, 46% of the participants were regarded as severe procrastinators. Combining the two revealed that among those being classified as severe procrastinators on the PPS, 74% were also identified as such based on the criteria of the PDC. Likewise, 86% of the participants being severe procrastinators on the PDC were recognized as such on the PPS. Overall, there was an overlap of 80% between the two methods for differentiating severe procrastination from less severe procrastination. Also, the 20% non-overlap was not equally distributed between the severe cases (32% of non-overlap), and less severe cases (68% of non-overlap) of procrastination. In other words, both ways might be reliable in identifying cases of severe procrastination, but the PPS could potentially overreport the number of severe cases. Furthermore, the PDC might be more sensitive to gender differences as it demonstrates that the proportion of female participants in the group "severe procrastination" is lower than the proportion of female non-severe procrastinators.

Physical and Psychological Issues of Procrastination

Physical Issues

The participants reported a large number of physical issues that are considered emblematic of *Stress and anxiety*, see **Table 5** for an overview. These could in turn be organized according to six subthemes; *Tension* (e.g., feeling tensed around your shoulders, neck, and back), *Pain* (e.g., bruxism, muscular pain, and experiencing recurrent headaches or migraine), *Sickness* (e.g., nausea, dizziness, and shudders), *Stomach* (e.g., increased or decreased appetite, stomach aches, and diarrhea), and *Sleep and rest* (e.g., insomnia, tiredness, and restlessness). In a majority of the cases, participants described having more than one symptom, such as feeling stressed out, having difficulties sleeping, and being restless.

Among the less common physical issues, *Other,* these were characterized by the worsening of an already underlying condition, such as eczema, causing flare ups or exacerbated

TABLE 2 | Differentiating severe procrastination from less severe procrastination.

		Less severe procrastination			Severe procrastination					
		N	Yes	In %	*N*	Yes	In %	Pearson Chi^2	*df*	*p*
Female	PPS	344	233	68	385	255	66	0.18	1	0.67
	PDC	396	283	71	333	205	62	8.02	1	0.0046
Presently has a diagnosed psychiatric disorder	PPS	344	26	8	388	75	19	21.24	1	0.000
	PDC	398	43	11	334	58	17	6.57	1	0.0104
Considers procrastination a problem	PPS	344	143	42	388	374	96	261.17	1	0.000
	PDC	398	193	48	334	324	97	206.03		0.000
Has considered seeking help	PPS	344	18	5	388	134	35	26.92	1	0.000
	PDC	398	26	7	334	126	38	37.65		0.000
Meets procrastination criteria	PPS	344	48	14	388	286	74	262.46	1	0.000
GAD-7 score < 5 (no anxiety)	PPS	344	162	47	388	88	23	61.39	3	0.000
	PDC	398	182	46	334	68	20	73.9	3	0.000
GAD-7 score ≥ 5 (mild anxiety)	PPS	344	104	30	388	128	33			
	PDC	398	126	32	334	106	32			
GAD-7 score ≥ 10 (moderate anxiety)	PPS	344	51	15	388	87	22			
	PDC	398	59	15	334	79	24			
GAD-7 score ≥ 15 (severe anxiety)	PPS	344	27	8	388	85	22			
	PDC	398	31	8	334	81	24			
PHQ-9 score < 5 (no depression)	PPS	344	155	45	388	60	15	111.86	4	0.000
	PDC	398	173	43	334	42	13	122.84	4	0.000
PHQ-9 score ≥ 5 (mild depression)	PPS	344	111	32	388	109	28			
	PDC	398	125	31	334	95	28			
PHQ-9 score ≥ 10 (moderate depression)	PPS	344	48	14	388	98	25			
	PDC	398	64	16	334	82	25			
PHQ-9 score ≥ 15 (moderately severe depression)	PPS	344	19	6	388	71	18			
	PDC	398	22	6	334	68	20			
PHQ-9 score ≥ 20 (severe depression)	PPS	344	11	3	388	50	13			
	PDC	398	14	4	334	47	14			

*GAD, Generalized Anxiety Disorder Questionnaire; PHQ, Patient Health Questionnaire. *p < 0.007 (Bonferroni correction).*

problems. However, a few participants also mentioned biting their nails when under stress or experiencing problems with gastritis or becoming numb.

Psychological Issues

In terms of the psychological issues, there was a clear overlap with many of the physical symptoms described above, see **Table 6** for an overview. One of the overarching themes, *Stress and anxiety,* included four subthemes; *Sleep and rest* (e.g., insomnia, tiredness, restlessness, and feeling exhausted), *Fear* (e.g., worrying about your current situation or the future and feelings of panic), *Cognitive load* (e.g., having difficulties concentrating and remembering things), and *Performance* (e.g., experiencing performance anxiety or having difficulties achieving high standards).

Apart from being stressed out and anxious, most participants also described having a lower mood, and feelings of hopelessness and despair. This overarching theme, *Depression,* consisted of three subthemes; *Self-criticism* (e.g., self-loathing, feelings of disappointment with oneself, and negative thoughts), *Remorse* (e.g., anger, frustration, and feelings of shame), and *Self-esteem* (e.g., feeling inadequate and experiencing a loss of self-confidence).

Less prevalent were signs of *Other* conditions and symptoms, such as eating disorders, compulsions, and social anxiety, although a few participants experienced these issues in relation to their procrastination.

DISCUSSION

General Discussion

The first aim of the current study was to explore ways of differentiating students who might require professional help for procrastination from those with less pressing matters. Overall, the findings suggest that cases of severe procrastination, as determined using either the PPS or the PDC, are characterized by higher levels of anxiety, depression, and stress than the less severe cases, representing moderate to large between-group effect sizes. Given the magnitude of these differences, severe procrastinators could therefore warrant further assessment and possibly even treatment, such as via a student health center. Furthermore, severe procrastination was associated with greater self-reported negative effects on all of the life-domains that were examined, most notably for work/studies, but also for physical activity/diet and rest/sleep, which resemble previous research on

TABLE 3 | Differentiating severe procrastination from less severe procrastination.

		Less severe procrastination			Severe procrastination						
		N	*M*	*SD*	*N*	*M*	*SD*	t	df	p	d
Age	PPS	344	30.03	9.35	388	27.76	7.08	3.66	635.02	0.00*	0.28
	PDC	398	29.94	9.03	334	27.51	7.12	4.07	727.18	0.00*	0.30
Education credits	PPS	343	215.38	151.25	384	176.78	128.35	3.72	725	0.00*	0.28
	PDC	396	218.61	142.60	331	166.74	133.55	5.03	725	0.00*	0.37
Age start procrastination	PPS	143	18.44	7.15	374	16.45	5.51	3.00	209.60	0.00	0.33
	PDC	193	17.90	6.79	324	16.47	5.53	2.60	515	0.01	0.24
Effect of procrastination in life-domain											
Interests/leisure	PPS	143	3.48	2.70	374	5.13	2.90	5.89	515	0.00*	0.58
	PDC	193	3.95	2.77	324	5.10	2.96	4.38	515	0.00*	0.40
Work/studies	PPS	143	6.26	1.96	374	8.33	1.57	11.36	215.56	0.00*	1.23
	PDC	193	6.51	1.92	324	8.51	1.49	12.39	328.47	0.00*	1.20
Friendships/social life	PPS	143	3.24	2.56	374	4.99	2.74	6.61	515	0.00*	0.65
	PDC	193	3.72	2.61	324	4.97	2.81	5.02	515	0.00*	0.46
Community/engagement/ Spirituality	PPS	143	2.08	2.57	374	3.48	3.32	5.05	329.58	0.00*	0.44
	PDC	193	2.53	2.90	324	3.42	3.31	3.19	445.93	0.00*	0.28
Family life/parenting	PPS	143	2.83	2.44	374	4.05	2.87	4.87	300.63	0.00*	0.45
	PDC	193	3.05	2.64	324	4.11	2.84	4.28	426.73	0.00*	0.38
Rest/sleep	PPS	143	5.27	2.98	374	6.77	2.89	5.23	515	0.00*	0.51
	PDC	193	5.62	3.03	324	6.80	2.88	4.43	515	0.00*	0.40
Love/intimate relationships	PPS	143	2.97	2.84	374	4.10	3.25	3.91	292.19	0.00*	0.36
	PDC	193	3.24	3.10	324	4.11	3.18	3.03	515	0.00	0.28
Physical activity/diet	PPS	143	4.78	2.76	374	6.50	2.86	6.29	265.52	0.00*	0.61
	PDC	193	5.21	2.99	324	6.50	2.79	4.87	381.28	0.00*	0.45

*$p < 0.002$ (Bonferroni correction)

the impact of procrastination on both academic achievement and health (e.g., Grunschel et al., 2013; Kim and Seo, 2015). In addition, quality of life was more negatively affected among severe procrastinators, corresponding to moderate between-group effect sizes, although, the level of quality of life was not as impaired as has been found in clinical samples (Lindner et al., 2016). As for impulsivity, those with severe procrastination were far more susceptible to temptation, a difference consistent with a large between-group effect sizes, which is in line with the idea of impulsivity being one of the strongest personality traits predictive of procrastination (Steel, 2007). With regard to perfectionism, only emotional concerns differed between severe and less severe procrastinators, corresponding to large between-group effect sizes. Similar to the findings by Sirois et al. (2017), emotional, or, neurotic, aspects of perfectionism thus appear to be much more strongly related to severe procrastination, suggesting that students who are concerned about making mistakes and not living up to certain standards might need treatment that specifically target these issues.

When explicitly asked about it, severe procrastinators seem to regard procrastination as a problem to a much greater extent than less severe procrastinators (96 and 97%, in comparison to 42 and 48%, depending on whether the PPS or the PDC was used for differentiation), something they also report having been more inclined to seek help for (35 and 38% compared to 5 and 7%). This is the first time such direct queries have been used to determine if someone might need further assistance, giving some credence to the results and pointing toward the utility of using either the PPS or the PDC to identify severe cases of procrastination. However, as indicated in the current study, the PPS could potentially overreport the number of severe cases. Meanwhile, the PDC might be more sensitive to gender differences as it demonstrates that the proportion of female participants among the severe procrastinators is significantly lower than the proportion of female participants among the less severe procrastinators.

Another aim of the current study was to understand the physical and psychological issues related to procrastination by investigating the responses to two open-ended items. In terms of the former, the results demonstrate that many students who procrastinate experience symptoms that are commonly seen in stress and anxiety, such as being tensed, having sleeping problems, and struggling with different forms of pain. These issues are in line with the findings by Grunschel et al. (2013) who also reported a high incidence of such consequences from procrastinating. In addition, it corroborates the procrastination-health model by Sirois (2007), which proposed that stress might act as a mediator between procrastination and many physical issues. The idea that procrastination is associated with stress, and, in turn, leads to other concerns, is reasonable given the nature of procrastination. While it may decrease discomfort temporarily (cf. Sirois and Pychyl, 2013), the activity being postponed still has to be performed on a later occasion, causing more stress overall (Tice and Baumeister, 1997).

TABLE 4 | Differentiating severe procrastination from less severe procrastination.

		Less severe procrastination			Severe procrastination						
		N	*M*	*SD*	*N*	*M*	*SD*	*t*	*df*	*p*	*d*
Pure Procrastination Scale	PPS	344	2.20	0.53	388	3.71	0.50	39.43	730	0.00*	2.92
	PDC	398	2.46	0.75	334	3.65	0.62	23.58	729.93	0.00*	1.72
Susceptibility to Temptation Scale	PPS	344	2.60	0.81	388	3.64	0.73	18.20	695.24	0.00*	1.36
	PDC	398	2.70	0.85	334	3.68	0.72	16.97	729.95	0.00*	1.24
Clinical Perfectionism Questionnaire (Personal Standards)	PPS	344	2.73	0.63	388	2.60	0.62	2.71	730	0.01	0.20
	PDC	398	2.70	0.61	334	2.61	0.65	1.98	730	0.05	0.15
Clinical Perfectionism (Emotional Concerns)	PPS	344	2.64	0.74	388	3.19	0.68	10.49	730	0.00*	0.78
	PDC	398	2.65	0.75	334	3.26	0.62	12.05	729.99	0.00*	0.88
Generalized Anxiety Disorder Questionnaire	PPS	344	6.08	4.96	388	9.42	5.66	8.53	729.90	0.00*	0.63
	PDC	398	6.17	4.92	334	9.85	5.69	9.25	662.48	0.00*	0.70
Patient Health Questionnaire	PPS	344	6.33	5.36	388	11.28	6.24	11.53	729.28	0.00*	0.85
	PDC	398	6.65	5.52	334	11.70	6.15	11.59	676.20	0.00*	0.87
Perceived Stress Scale	PPS	344	2.59	0.58	388	3.19	0.57	− 14.28	730	0.00*	1.06
	PDC	398	2.65	0.59	334	3.22	0.58	− 13.08	730	0.00*	0.97
Brunnsviken Brief Quality of Life Scale: Leisure	PPS	344	8.74	4.72	388	7.10	4.75	4.68	730	0.00*	0.35
	PDC	398	8.71	4.60	334	6.87	4.86	5.25	730	0.00*	0.39
Brunnsviken Brief Quality of Life Scale: View of Life	PPS	344	10.78	4.80	388	8.72	5.23	5.52	730	0.00*	0.41
	PDC	398	10.59	4.80	334	8.61	5.33	5.23	677.10	0.00*	0.39
Brunnsviken Brief Quality of Life Scale: Creativity	PPS	344	7.49	4.96	388	6.24	5.19	3.32	730	0.00*	0.25
	PDC	398	10.59	4.80	334	8.61	5.33	5.23	677.10	0.00*	0.39
Brunnsviken Brief Quality of Life Scale: Learning	PPS	344	10.83	4.64	388	8.53	5.11	6.35	7300	0.00*	0.47
	PDC	398	7.47	4.87	334	6.07	5.31	3.74	730	0.00*	0.28
Brunnsviken Brief Quality of Life Scale: Friends	PPS	344	10.69	5.07	388	8.93	5.41	4.52	730	0.00*	0.45
	PDC	398	10.56	5.06	334	8.81	5.47	4.49	730	0.00*	0.33
Brunnsviken Brief Quality of Life Scale: Self	PPS	344	10.29	4.71	388	7.29	4.90	8.42	730	0.00*	0.62
	PDC	398	9.96	4.70	334	7.20	5.02	7.65	730	0.00*	0.57
Brunnsviken Brief Quality of Life Scale: Total	PPS	344	58.83	19.83	388	46.82	20.81	7.97	730	0.00*	0.59
	PDC	398	58.11	19.09	334	45.74	21.66	8.12	669.99	0.00*	0.61

*$p < 0.002$ (Bonferroni correction).

TABLE 5 | Physical issues of procrastination.

Theme	Subthemes	Characteristics	Example
Stress and anxiety			
	Tension	Feeling tensed around your shoulders, neck, and back	*"Physical signs of anxiety with headaches, tensions in my neck and shoulders, and difficulties relaxing."*
	Pain	Bruxism, muscular pain, headaches, and migraine	*"Pain in my back and neck when I have to study long hours before an exam, which I've procrastinated."*
	Sickness	Nausea, dizziness, and shudders	*"Dizziness, inertia, and brain fog."*
	Stomach	Increased or decreased appetite, stomach aches, and diarrhea	*"Lack of appetite, followed by periods of overindulgence."*
	Sleep and rest	Insomnia, tiredness, and restlessness	*"Difficulties sleeping. I wake up at night several times and am unable to go back to sleep."*
	Other	Worsening of an underlying condition (e.g., eczema or irritable bowel syndrome) or other symptoms (e.g., biting your nails)	*"Mostly stomach issues. I was diagnosed with IBS* [irritable bowel syndrome] *when I was 17. Always get an upset stomach when I'm stressed out over tasks or when I'm stressed out in general."*

As for the psychological issues, these were also characterized by symptoms of stress and anxiety, for example, insomnia, restlessness, and worry, suggesting a high degree of overlap with the physical issues. Again, this corresponds to the results by Grunschel et al. (2013), and should be seen as the affective and somatic effects of being anxious and stressed out from procrastinating. Furthermore, difficulties concentrating and remembering things are not uncommon when under stress,

TABLE 6 | Psychological issues of procrastination.

Theme	Subthemes	Characteristics	Example
Stress and anxiety			
	Sleep and rest	Insomnia, tiredness, restlessness and exhaustion	*"Difficulties sleeping, particularly with regard to falling asleep, but also waking up at night, often between 3 and 4 a.m."*
	Fear	Worry and panic	*"Anxious about falling behind, not being able to succeed on my exams."*
	Cognitive load	Difficulties concentrating and remembering things	*"Anxiety, worry, difficulties concentrating, and problems remembering things."*
	Performance	Performance anxiety and difficulties achieving high standards	*"Anxiety preceding tests and exams that I wasn't able to commit study hours toward."*
Depression	Self-criticism	Self-loathing, feelings of disappointment, and negative thoughts	*"Self-loathing (pushing myself down, feel incapable of doing things, etc. Constantly comparing myself to others."*
	Remorse	Anger, frustration, and shame	*"Anxiety, remorse, and shame that I continue to procrastinate even though I know it's stupid."*
	Self-esteem	Feeling inadequate and loss of self-confidence	*"Anxiety, disappointment, stress, fear, lower self-esteem, inadequate, not being smart enough, and that you're not worthwhile."*
Other	Other	Eating disorders, compulsions, and social anxiety	*"Panic, a mild form of self-harm, a general sense of disappointment which affects the way I perceive myself."*

thereby affecting the possibility to pursue a given action (Marin et al., 2011), as reported by many participants in the current study. However, a noticeable difference between the physical and psychological issues are aspects related to performance, self-criticism, remorse, and self-esteem. These might portray the more depressogenic impact of procrastination, such as being disappointed with oneself, experiencing lower self-confidence, and exhibiting negative self-evaluation. This goes in line with the notion of efficacy-performance spirals, whereby the inability to execute goal-directed behaviors and progress toward a given end-point can lead to lower mood, self-loathing, and decreased motivation (Lindsley et al., 1995). In other words, procrastination does not only appear to cause stress and anxiety in the aftermath of a procrastination episode, but also negatively impacts the general state of the individual by inducing self-doubt, frustration, shame, rumination, and feelings of inadequacy (cf. Giguère et al., 2016; Constantin et al., 2018). When demonstrating such depressive thoughts and feelings, it is then not unreasonable to expect the person to be less inclined to take care of the assignments that need to be done, further perpetuating a downward cycle.

Practical Implications and Recommendations

Based on the results from the current study, the PPS is recommended as an initial screening tool for large samples, such as when admitting new students to a study program or as a general assessment of well-being at a university. As a second step, students who score higher than a certain cut-off (e.g., 3.00 like in the present study) on the items should be advised to fill out the PDC to more accurately determine the severity level of procrastination and its associated physical and psychological issues. This procedure could, for instance, be implemented at a student health center in order to identify those students in need of professional help, although it should be noted that the PDC has so far only been used in this way in Germany. In addition, administering the GAD-7 and PHQ-9 on the same occasion gives some indication of symptoms of anxiety and depression. This would inform therapists of other possible conditions that might warrant their attention, such as major depressive disorder, which sometimes have to be dealt with first in treatment. Furthermore, for those who seek support for procrastination, discussing the criteria of the PDC and the physical and psychological issues presented in the current study might help them understand what they are experiencing and how to overcome their problems. This type of psychoeducation can often have a normalizing effect, reducing shame and stigma, and, in turn, motivate behavior change. Similarly, career counselors might use the PDC in relation to discussing study satisfaction and dropout intentions in order to prevent students ending their studies prematurely (Scheunemann et al., 2021).

Apart from aiding the identification of severe procrastinators, the findings from the current study may also have implications for treatment. The physical and psychological issues reported by the participants suggest that symptoms of stress and anxiety are common. On the one hand, procrastination can sometimes be a response to this discomfort. On the other hand, procrastinating an activity can also give rise to this distress (Rozental and Carlbring, 2014). In both cases, interventions targeting symptoms of stress and anxiety seem important in order to overcome many difficulties experienced by students, which can involve goal-setting, problem-solving, time management, and exposure to negative emotions, as have been tested in clinical trials (e.g., Rozental et al., 2015, 2018). The basic tenet is to lower stress levels and help endure those feelings that might otherwise lead one astray. Moreover, the depressogenic impact of procrastination may cause the individual to feel less willing to initiate goal-directed behaviors. Similar to the actions of someone suffering from major depressive disorder, this however, prevents the person from experiencing mastery and joy, furthering a vicious process of passivity and negative self-evaluation. Interventions that focus on activity scheduling and step-wise performance of activities might therefore be

key to overcoming inaction and self-loathing, i.e., behavioral activation (Ramsay, 2002). Likewise, students who may be experiencing low self-efficacy due to their procrastination could benefit from study skills training (Svartdal et al., 2021). Concerning the different phases of a procrastination episodes (Svartdal et al., 2020b), it might even be worthwhile to differentiate between strategies that upregulate motivation as in motivational regulation strategies (Grunschel et al., 2016), and strategies that downregulate negative affect (Eckert et al., 2016), thus, tailoring them to the specific needs of the student. Furthermore, the environment for many students also seems to result in procrastination and might have to be targeted. Svartdal et al. (2020a) provide an overview of the measures that could be taken by course coordinators and lecturers, such as study skills training, group work, and courses in self-regulation.

Limitations

The current study is, to the knowledge of the authors, the first attempt at differentiating the more severe from less severe procrastinators among university students. It has furthered the understanding of what characterizes problematic forms of procrastination and provided recommendations on how to screen and support those experiencing difficulties completing their commitments. However, there are also several limitations that need to be addressed.

First, recruitment of participants was made via advertisements and information distributed universities and in relevant forums. Although a reasonable way of reaching university students, it might also have attracted proportionally more individuals with greater problems of procrastination or, the other way around, those for whom procrastination is just a little nuisance. This self-selection bias might have affected the possibility to differentiate between "severe procrastination" and "less severe procrastination." The distribution of scores on the self-report measures do not seem to suggest that this is the case, but future research should try alternative methods of recruiting participants, such as stratified random sampling. Similarly, the current study focused on students in university settings only, making it unclear whether the results can be generalized to an adult working population or younger students in elementary school or high-school. Replicating the approach used here should be feasible in other settings in order to determine if the same type of classification is possible to make elsewhere. Replicating the approach in a longitudinal design would, furthermore, deliver information on causal relationships between procrastination and psychopathological symptoms.

Second, the current study was conducted during the fall semester of 2020, which is about 6 months into the COVID-19 pandemic. Similar to other countries, universities in Sweden shut down on-campus education during the spring of the same year, meaning that most curricular activity was performed online when the participants responded to the survey. Whether this has affected university students' levels of procrastination is not known, but given the lack of routines and social support it is reasonable to assume that it has been detrimental to some. Furthermore, the COVID-19 pandemic itself, and its effects of everyday life, might have affected the physical and psychological well-being of some participants, thereby inflating the scores of the self-report measures somewhat.

Third, we used a median split on the PPS for differentiating the more severe from less severe procrastinators. In general, median splits, as practice for dichotomizing a continuous variable, have a long tradition of being criticized for the loss of information and reduction in power (e.g., Cohen, 1983). However, newer studies weaken this criticism considerably (e.g., Iacobucci et al., 2015a,b) by showing that this is in fact a robust method. For our purpose, it was very important to retain all information of the sample. Splitting the sample into three groups and only using the two extreme one would have resulted in a considerable loss of information, albeit useful for therapists. The median split of the PPS, however, and the diagnostic criteria used in the PDC, have not previously been tested regarding their classification accuracy for identifying more severe procrastinators. It is therefore unknown if these two methods can be applied for this purpose. Usually, a gold standard is used for comparison and validation, such as a structured clinical interview for determining major depressive disorder. However, such a diagnostic procedure is not possible for procrastination because it is not considered to be a diagnosis. Instead, the current study asked questions on whether the participants themselves regarded procrastination as a problem and if they ever considered seeking help for procrastination as a proxy for diagnosis. An idea for future research is to corroborate this method by interviews, which may provide additional insights on where to place the cutoff between severe and less severe procrastination.

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 Swedish Ethical Review Authority (Dnr: 2020-00555). The patients/participants provided their online informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AR and KK designed the study and outlined its research aims and drafted the manuscript. AR and DF applied for ethics approval, set up the study, and monitored the data collection. AH advertised the study and managed the recruitment of participants. KK was responsible for the quantitative analyses. AR and DF was responsible for the qualitative analyses. DF and AH commented on the manuscript and approved its submission. All the authors contributed to the article and approved the submitted version.

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The reviewer TD declared a past co-authorship with one of the authors KK to the handling editor.

The handling editor declared a past co-authorship with one of the authors KK.

APPENDIX I

Comparing completers with non-completers.

	Completers (*N* = 732)		Non-completers					
	M	*SD*	*M*	*SD*	*N*	*t*	*df*	*p*
Age	28.83	8.30	28.82	6.85	65	0.12	795	0.99
Achieved education credits	194.99	140.85	174.14	113.90	64	1.15	789	0.25
Pure Procrastination Scale	3.00	0.91	2.98	1.00	13	0.08	743	0.94
Gender identity	67% female		70% female		64			
Civil status	44% single		56% single		63			
	54% married		40% married					
	2% divorced		5% divorced					
Children	At home 20%		At home 20%		65			
	Not at home 2%		Not at home 1%					
	No 78%		No 79%					

APPENDIX II

Descriptive statistics and correlations for the whole sample (*N* = 732).

		M	*SD*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Age	28.83	8.30	0.38**	−0.16**	−0.23**	0.04**	−0.17**	−0.16**	−0.20**	−0.17**	0.01**	0.11**	0.10**	0.24**	−0.02**	0.06**	−0.21**
2	Age_problematic	17.00	6.07		−0.18**	−0.21**	0.06**	−0.04**	0.03**	−0.02**	−0.01**	−0.11**	0.01**	−0.07**	0.06**	−0.03**	−0.03**	−0.22**
3	PPS	3.00	0.91			0.71**	−0.10**	0.43**	0.39**	0.48**	0.57**	−0.23**	−0.27**	−0.16**	−0.31**	−0.21**	−0.36**	−0.06**
4	STS	3.15	0.93				−0.13**	0.36**	0.30**	0.38**	0.44**	−0.10**	−0.22**	−0.07**	−0.27**	−0.12**	−0.30**	−0.24**
5	CPQ_Personal Standards	2.66	0.63					0.35**	0.31**	0.20**	0.17**	−0.20**	0.01**	0.02**	0.08**	−0.01**	−0.09**	0.20**
6	CPQ_Emotional Concerns	2.93	0.76						0.55**	0.55**	0.60**	−0.31**	−0.26**	−0.19**	−0.30**	−0.24**	−0.46**	0.07**
7	GAD	7.85	5.59							0.76**	0.70**	−0.43**	−0.33**	−0.24**	−0.31**	−0.29**	−0.45**	−0.17**
8	PHQ	8.95	6.34								0.72**	−0.45**	−0.40**	−0.26**	−0.40**	−0.34**	−0.55**	−0.30**
9	PSS	2.91	0.65									−0.48**	−0.38**	−0.30**	−0.42**	−0.34**	−0.54**	−0.50**
10	BBQ_Leisure	7.87	4.81										0.40**	0.40**	0.33**	0.43**	0.41**	0.39**
11	BBQ_View of Life	9.68	5.14											0.42**	0.41**	0.38**	0.53**	0.24**
12	BBQ_Creativity	6.83	5.12												0.40**	0.28**	0.30**	0.54**
13	BBQ_Learning	9.61	5.03													0.29**	0.40**	0.48**
14	BBQ_Friends	9.76	5.32														0.38**	0.35**
15	BBQ_Self	8.70	5.04															0.23**
16	BBQ_Total	52.46	21.21															

*Age_problematic, age procrastination started to be perceived as problematic; PPS, Pure Procrastination Scale; STS, Susceptibility to Temptation Scale; CPQ, Clinical Perfectionism Scale; GAD, General Anxiety Scale; PHQ, Patient Health Questionnaire; PSS, Perceived Stress Scale; BBQ, Brunnsviken Brief Quality of Life Scale. *$p \leq 0.5$, **$p \leq 0.1$.*

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"I'll Worry About It Tomorrow" – Fostering Emotion Regulation Skills to Overcome Procrastination

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Procrastination remains an omnipresent phenomenon impeding especially students' academic performance and well-being. Preliminary findings suggest that procrastination emerges due to dysfunctional emotion regulation efforts to regulate aversive emotions. This study's objective was to clarify whether the enhancement of general adaptive emotion regulation skills reduces subsequent procrastination. For the purpose of this study, data from a two-armed randomized controlled trial (RCT) with (N = 148) university students, comprising an active intervention (IG) and a passive wait-list control (WLC) group, was collected. Participants of the intervention group were provided with an online emotion regulation training over a period of 9 weeks. The results showed that the enhancement of general emotion regulation skills significantly reduced subsequent procrastination behavior within the IG as compared to the untreated WLC. Moreover, subsequent mediation analyses revealed that the reduction of procrastination was significantly mediated by the increase in general ER skills. The present results suggest that trainings which enhance general ER skills are an appropriate measure to reduce procrastination behavior among university students. The practical value of ER training interventions, particularly for student populations, is discussed.

Keywords: overcoming procrastination, emotion regulation, emotion regulation skills training, e-mental health intervention, procrastination, stress intervention

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INTRODUCTION

In recent years, increasing research has addressed the question, why individuals rather watch cat videos online (Myrick, 2015), and students prefer to watch TV or sleep instead of executing their mandatory tasks (Pychyl et al., 2000). Procrastination remains a widespread phenomenon, whose existence, according to Steel (2007), can be traced back to 400 BC. Today, more than two thousand years later, we are still in the process of understanding the phenomenon. Approximately 15–20% of the total adult population suffers from chronic procrastination (Harriott and Ferrari, 1996; Ferrari et al., 2007; Steel, 2007), and over 95% wishes to minimize their procrastination behavior (O'Brien, 2002). Among student populations, the prevalence is even higher. Estimates show that 80–95% of students engage in occasional procrastination (Steel, 2007), and approximately 50% suffer from chronic, detrimental procrastination behavior (Day et al., 2000; He, 2017). Although some researchers argue that procrastination does not only comprise negative effects (Chu and Choi, 2005), most research has put forward that procrastination highly

impedes indicators of success and performance (Steel, 2007; Gareau et al., 2018), individuals' mental (Strongman and Burt, 2000; van Eerde, 2003; Sirois and Pychyl, 2013) and even physical health (Sirois, 2015). With regard to these figures, procrastination remains a well-discussed topic in psychological research and must be targeted in order to enhance individuals' and especially students' performance, health and overall well-being. The key question that needs to be provided with empirical evidence is how the phenomenon can be overcome and the resulting issues diminished.

In current literature, procrastination is generally understood as "to postpone completing a task from the present or near future to a more distant future" (Gautam et al., 2019, p. 1). The term procrastination originates from the Latin words pro, meaning "in favor of or forward," and crastinus, meaning "of tomorrow" (Steel, 2007, p. 66). Procrastination encompasses a voluntary and irrational delay of an intended action (Ellis and Knaus, 1977; Burka and Yuen, 1983; Akerlof, 1991; Steel, 2007; Sirois and Pychyl, 2013), despite the awareness that one will not maximize one's gains (e.g., personal interests, preferences, material, and psychological goals; Steel, 2007), instead harm one's future-self by this course of action (Sirois and Pychyl, 2013). By procrastinating, we expect "that tomorrow will be different [. . .] that we will be different tomorrow" (Sirois and Pychyl, 2013, p. 116). However, procrastinators deliberately and irrationally postpone an intended action although anticipating being worse off after, due to the negative consequences caused by the delay (Steel, 2007; Klingsieck, 2013; Sirois and Pychyl, 2013).

Procrastination as a Dysfunctional Emotion Regulation Strategy

In previous literature the ability to regulate emotions adaptively and properly in explaining the general tendency to procrastinate has been stressed (e.g., Tice and Baumeister, 1997; Tice and Bratslavsky, 2000; Sirois and Pychyl, 2013; Eckert et al., 2016). Several researchers have suggested that procrastination is rooted in the application of a dysfunctional emotion regulation strategy (Sirois and Pychyl, 2013, 2016; Eckert et al., 2016) resulting from emotional misregulation (Sirois and Pychyl, 2013). Moreover, it has been highlighted that aversive emotions represent the key antecedents of procrastination (Steel, 2007; Eckert et al., 2016; Pollack and Herres, 2020).

Accordingly, investigating how the enhancement of adaptive emotion regulation skills affects subsequent procrastination behavior could help improving existing and developing novel interventions to reduce procrastination and its associated adverse effects. Thus, this study will first theoretically and subsequently experimentally demonstrate how the enhancement of general adaptive emotion regulation skills could aid in overcoming the illustrated phenomenon.

Diverse intervention programs to reduce procrastination have been developed and evaluated (van Eerde and Klingsieck, 2018), including interventions based on Cognitive Behavioral Therapy (Toker and Avci, 2015; Eckert et al., 2018; Rozental et al., 2018), based on self-regulation (Grunschel et al., 2018) and emotion regulation strategies (Eckert et al., 2016), and interventions building on Acceptance and Commitment Therapy (ACT) and mindfulness (Dionne, 2016). Evidently, the majority of the existing intervention programs include emotion regulation processes and address them in a direct or indirect manner. To improve and sharpen the existing interventions, it is necessary to understand how the enhancement and acquisition of adaptive emotion regulation skills affects subsequent procrastination.

Emotion Regulation

Emotion regulation (ER) is defined as a multifaceted and broad construct including all "extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals" (Gross, 2007, p. 251). Preliminary findings suggest that individuals engage in ER processes to enhance pleasure and prevent pain (Larsen, 2000; Gross, 2014). The most scientifically examined model, the Process Model of Emotion Regulation by Gross (1998, 2014), portrays the different steps of the emotion-generative process. It distinguishes between five strategies that individuals can engage in order to regulate their emotions: (1) situation selection, (2) situation modification, (3) attention deployment, (4) cognitive change, and (5) response modulation. These strategies each target a different emotion-generative step and can be addressed to influence the emotional dynamics of the emotional response (Thompson, 1990), including the intensity, duration, magnitude, and offset of behavioral, physiological, and experiential responses (Gross, 1998). Engaging in healthy ER processes, thereby, refers to the ability to alter how intensely, how long, and how fast one feels one's emotion, rather than changing the valence of one's emotion (Gross, 2007). Accordingly, ER as a process includes the upregulation and downregulation of the extent or duration of one's emotional responses by applying several emotion-focused strategies (Gross, 2014; Sirois and Pychyl, 2016). These ER strategies are rarely maladaptive or ideal by definition, instead, the strategies must be considered in the context of a person's goal for a certain situation (Gross, 2007). Regarding procrastination, the engagement in certain ER strategies can be dysfunctional, if they involve the downregulation of aversive emotions at the cost of one's previous formed intentions and goals. According to Sirois and Pychyl (2016) procrastination can be understood as a self-regulatory failure that arises due to preceding aversive emotions, such as frustration, boredom, negative affect, anxiety, and worry (Blunt and Pychyl, 2000) resulting from the exposure to unpleasant and aversively perceived tasks (Lay, 1990). Thus, by procrastinating, the engagement in the voluntarily delay of unpleasant but mandatory tasks, individuals manage to avoid the experience of the aversive emotions in short-term, albeit fail to achieve their long-term goals (Sirois and Pychyl, 2016). Respectively, aversive affective states have been proposed to represent the key antecedents of procrastination (Eckert et al., 2016; Pollack and Herres, 2020). Accordingly, when considering procrastination as a self-regulatory failure resulting from emotional misregulation, it follows logically that the acquisition of ER skills to cope with aversive emotions adaptively may aid in preventing procrastination.

Emotion Regulation Skills

As depicted in the previous section, ER represents an exceedingly dynamic process (Ochsner and Gross, 2007). Apart from the outlined ER strategies, ER can be understood as skills operating in the ER process. These skills can be conceptualized as an element of the ER process and are fundamental for adaptive coping with aversive emotional states, and therefore, the engagement in healthy ER processes (Berking et al., 2008, 2012). To provide a conceptual framework for the relevant ER skills involved in adaptive ER processes and adaptive coping Berking and Whitley (2014a) have put forward the Adaptive Coping with Emotions Model (ACE; Berking and Whitley, 2014b).

According to the ACE model, adaptive ER is defined as the situation-adapted interaction of the ER skills to: (1) be aware of one's emotions, as it represents a prerequisite for conscious emotion regulation, (2) identify and correctly label one's emotions, as it facilitates the management of the experienced emotions, (3) correctly interpret emotions related to bodily sensations, as it aids in avoiding misinterpretations that can fuel psychological or psychosomatic symptoms, (4) understand the cause of emotions, as it permits the discovery of opportunities of change, (5) adaptively modify aversive emotions to enhance one's emotional state and build self-efficacy, (6) accept one's emotions, as the non-acceptance of one's emotions fuels the emergence of further negative emotions, (7) be resilient (tolerate and accept aversive emotions), as dysfunctional control efforts contribute toward the maintenance of negative emotions and emotions are regulated by brain regions that elude voluntary control efforts (Berking, 2010), (8) emotionally support oneself in distressing situations to avoid impulsive behavioral mood-repair responses, and (9) confront distressing situations eliciting negative emotions to acquire effective ER competencies and build resilience (Berking and Znoj, 2008).

In view of the ACE model, adaptive ER skills enable adaptive coping with aversive emotions. In line with previous research (Eckert et al., 2016; Sirois and Pychyl, 2016), this study considers procrastination as a dysfunctional ER strategy and precisely a maladaptive coping advance, concerning the dysfunctional regulation of aversive emotions. Therefore, deficits in ER skills can be considered as the origin of the misregulative emotional nature of procrastination.

Previous research indicates that general ER skills can be acquired and fostered (Berking et al., 2008; Berking and Lukas, 2015; Eckert and Tarnowski, 2017). As the significance of adaptive ER skills to preserve mental and physical health and prevent psychopathological symptoms has been shown by numerous studies (Wirtz et al., 2013; Berking et al., 2014; Trindade et al., 2017; Cloitre et al., 2019), it is proposed that deficits in ER skills must be altered to allow adaptive coping with the preceding aversive emotions, and consequently prevent procrastination, the resulting distress, and the adverse health consequences.

Objective and Hypotheses

In light of the given evidence, it is expected that the enhancement of general ER skills prevents subsequent procrastination behavior. A pioneering study by Eckert et al. (2016) was the first to cross-sectionally and longitudinally demonstrate that ER skills affect subsequent procrastination behavior. Moreover, within a 2-week RCT they showed that the enhancement of task-related ER skills significantly reduced procrastination among university students. Prior research, therefore, is limited to the enhancement of ER skills cued by tasks. Despite the interest, the enhancement of task-unrelated general ER skills aimed at reducing procrastination has not been studied yet. By further investigating this research gap, it is intended to expand current scientific literature on the interrelationship of procrastination and ER. Most importantly, it is intended to provide empirically founded knowledge on feasible interventions targeting the reduction of procrastination and its associated detrimental effects. Given that the present intervention is conducted on a university student sample, with respect to educational purposes, this research aims at providing a contribution toward a successful intervention program targeting academic procrastination to enhance performance and well-being among students.

The present study investigates the effects of an online emotion regulation skills training on subsequent procrastination behavior among university students. First, we assume that the intervention increases general ER skills (hypothesis 1) compared to a waiting-list control group (WLC). In line with hypothesis 2, this study postulates that the present ER intervention results in a significant reduction of the dependent variable, procrastination, among the intervention group (IG) from baseline (t1) to post-measurement (t2) as compared to WLC. In hypothesis 3, it is proposed that the expected treatment effect (the reduction of procrastination at t2) will be attributed to the overall acquisition of adaptive ER skills and will be tested using a mediation analysis.

> ***H1*** **(Treatment Efficacy)**: Participants of the intervention group (IG) will significantly increase general ER skill from t1 to t2 in comparison to participants of the WLC.
>
> ***H2*** **(Treatment Efficacy)**: Participants of the intervention group (IG) will significantly procrastinate less from t1 to t2 in comparison to participants of the WLC.
>
> ***H3*** **(Mediation Analysis)**: The reduction of participants' procrastination behavior at t2 will be significantly mediated by the overall increase in the participants' general ER skills.

MATERIALS AND METHODS

Research Design

The research design consisted of a two-armed randomized controlled trial (RCT) comprising an active intervention group (IG), provided with a 9-week online ER training enhancing general adaptive ER skills, and a passive wait-list control group (WLC) without the administration of a placebo. The mixed-subject design measured the between factor *treatment* with two levels (intervention- vs. wait-list control group) and the within factor *time* with two levels [baseline (t1) vs. post-measurement (t2)]. Procrastination and ER were assessed prior to the treatment (t1), and immediately after the 9-week intervention period (t2). Based on prior findings (Eckert et al., 2016; Eckert and Tarnowski,

2017), the current intervention was expected to have at least a medium-sized effect on procrastination. According to the power analysis a total sample size of 138 participants was required to detect a medium effect size of $\eta^2 = 0.06$ with 95% power ($\alpha = 0.05$). Since a certain drop-out rate at post-measurement (t2) was to be expected, it was oversampled about 20% at baseline measurement (t1). Thus, the data collection at t1 was stopped once about 170 participants had registered for the study. All procedures were in line with the Institutional Review Board at Leuphana University of Lüneburg in Lüneburg, Germany.

Participants and Procedure

The sample of the present study mainly consisted of university students, as previous research indicated that approximately 50% of students report serious procrastination issues (Day et al., 2000). The participants were recruited from the Leuphana University of Lüneburg (Germany) via the university intern research participation platform Sona Systems[1] and other social networks between April 27th and May 6th, 2020. The data collection of the pre-measurement occurred during the recruitment period. The acquisition of the post-measurement data was conducted between June 26th and July 15th. Participants of the Psychology Department of the Leuphana University of Lüneburg were compensated with two credits as an incentive for their participation in the study. Students from all other departments and external students did not earn any further compensation in addition to the online training received free of charge.

All individuals that completed the baseline online survey (t1) and provided informed consent were included in the study. The presented questionnaires were in German and could be completed on a computer, tablet, or smartphone. The processing time was scheduled for approximately 15 min. The subjects were instructed to provide their email address and name. Shortly after, they received a personalized email with a link that forwarded them to the pre-measurement survey. Simultaneously, the integrated random generator randomized them toward IG or WLC and assigned them an internal serial number, enabling their identification at t2. The participants were asked to complete an online questionnaire measuring their baseline ER skills, procrastination scores, and socio-demographic data, comprising items regarding age, gender, and course of studies. Subsequently, the participants received an automated personalized email confirming their group allocation (IG vs. WLC). The IG directly received the online ER training "Stark im Stress" (*SIS*)[2] for 9 weeks. The WLC received the training right after the intervention period ended and the successful completion of the post-measurement questionnaire. After the intervention period of 9 weeks, all participants received a link via a personalized email, inviting them to complete a post-measurement questionnaire, consisting of the same procrastination and ER measures. Data protection was guaranteed at all times, as the analyses were carried out anonymously.

[1]https://leuphana.sona-systems.com/

[2]https://www.training-sis.de

At baseline measurement (t1), the sample consisted of $N = 171$ participants, whereof 85 participants were randomly assigned to the WLC and 86 to the IG (see **Figure 1** for the complete CONSORT flow diagram). As 23 (13.5%) cases, 10 from the WLC and 13 from the IG, had to be excluded due to unfinished questionnaires or drop-outs at post-measurement, the valid final sample size amounted to $n = 148$ participants, consisting of 111 women (75.0%), 36 men (24.3%), and 1 diverse gendered participant (0.7%). As some statistical tests regarding the sample characteristics could only be performed with two groups, the participant specifying diverse gender had to be excluded from those statistical analyses where gender constituted a factor. This measure should not be considered discriminatory under any circumstances. The average age of the participants was 22.6 years ($SD = 3.7$; men: $M = 23.8$, $SD = 5.0$; women: $M = 22.2$, $SD = 3.0$) with a range of 18–43 years. Within the final sample, 143 (96.6%) participants were currently enrolled as university students. The remaining five (3.4%) participants reported being employed. Of the 148 participants, 72 (48.6%) of the students indicated psychology as their course of studies, 40 (27.0%) law and economics, 14 (9.5%) participants declared the STEM fields as their major, 13 (8.8%) cultural, media and communication sciences and four (2.7%) social sciences. A Fisher's exact test indicated no significant allocation difference regarding gender and course of studies ($p = 0.608$). 75 participants were allocated toward the WLC and 73 toward the IG. A Mann–Whitney U test indicated that the participants were allocated to the IG and WLC evenly regarding age ($p > 0.05$). A Pearson chi-square test revealed a significant distribution difference regarding gender between treatments [$\chi^2(1) = 5.084$, $p < 0.05$], and a Fisher's exact test showed a significant difference regarding course of studies between the groups ($p < 0.05$).

Intervention

The participants were provided with the German online ER training "Stark im Stress" (Eckert and Tarnowski, 2017), consisting of three main modules. In line with previous findings (Berking et al., 2012; Eckert et al., 2016), each module addresses different ER skills, particularly focusing on the ER skills to tolerate, accept, and modify aversive emotions. The first module targets the enhancement of personal resources through the instruction and practice of mindfulness (Hill and Updegraff, 2012) and relaxation exercises (Berking and Whitley, 2014a), the establishment of positive emotions (Dalebroux et al., 2008; Alladin and Amundson, 2016), and regeneration. In the first session, the participants learn to evoke positive emotions by imaginations. In the following session, the participants receive an audio file supporting them in their practice of mindfulness and relaxation. The file includes a mindfulness exercise, which invites the participants to focus their attention on their breath. Additionally, it contains a guided exercise to practice a short version of progressive muscle relaxation, which requires approximately 15 min to complete (Dolbier and Rush, 2012). In session three, the participants are instructed to plan regeneration breaks and are taught how to cope with potential obstacles.

The second module encourages the participants to tolerate and accept negative emotions by applying behavioral activation

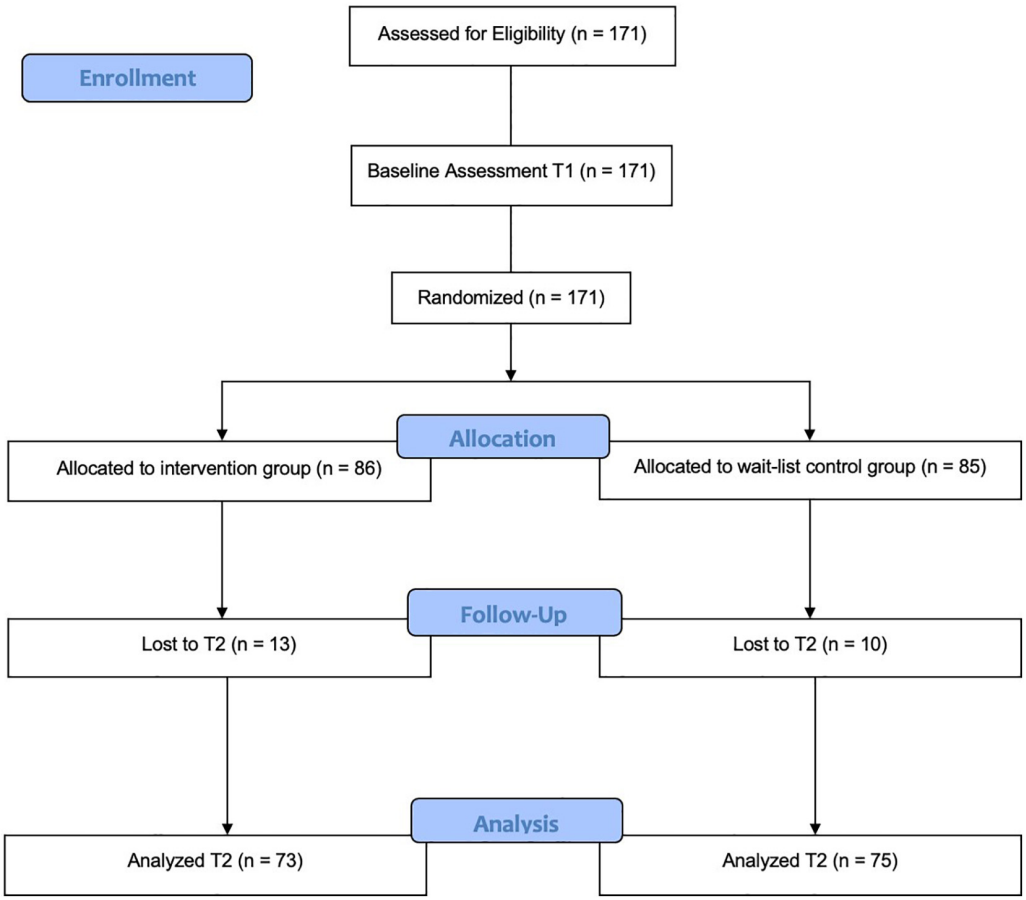

FIGURE 1 | CONSORT flow diagram.

techniques (Chu et al., 2009), self-esteem strategies (Berking and Whitley, 2014a; Kolubinski et al., 2018), and benefit-finding (Bower and Segerstrom, 2004). Therefore, in session four, the participants plan pleasant activities, which function as a prevention of negative moods. Session five focuses on benefit finding strategies. In session six, the participants are instructed to remember personal successes, their personal competencies, appreciations and self-cherishing in order to increase their self-esteem (Berking and Whitley, 2014a).

The third module aims at the modification of negative emotions by cognitive (Berking and Whitley, 2014a; Morris et al., 2015) and embodiment techniques (Tschacher and Pfammatter, 2016). Therefore, in the seventh session the participants are invited to apply embodiment techniques. In session eight the participants are requested to identify typical dysfunctional cognitions causing stress and learn how to modify them. In the last session the participants are instructed to integrate the strategies that personally work best for them in order to be able to adaptively cope with future aversive emotions.

Each module consisted of three 90-min units, comprising online educational video lessons and the accompanying support of a booklet. An additional app provided daily text message-based reminders to engage in quick ER exercises as the benefit of text messages has been shown to increase training adherence significantly (Eckert and Tarnowski, 2017), especially among procrastinators (Eckert et al., 2016). Message-based reminders may facilitate the initiation of action and apply the foot-in-the-door technique (Eckert et al., 2018).

Measurements

Procrastination

Procrastination was measured using the German short version of the General Procrastination Scale (*GPS*; Lay, 1986; German version: *GPS-K*; Klingsieck and Fries, 2012). Due to the lack of psychometric validity, Klingsieck and Fries (2012) factor-analytically revised the original GPS scale. The GPS-K is a self-report instrument including nine items that are each rated on a 4-point Likert-type response scale (1 = *extremely uncharacteristic* to 4 = *extremely characteristic*). Four of the nine items are inversed. A sample item is "I often find myself performing tasks that I had intended to do days before" (Lay, 1986). To compute a total scale score, all ratings are summarized and divided by the number of items (9). Higher values indicate higher self-reported procrastination behavior. In the present study, the internal consistency of the GPS-K was excellent (α_{t1} = 0.90).

The corrected item-total correlation (r_{it} = 0.63–0.76) and the test-retest reliability (r_{tt} = 0.81) indicated acceptable values.

Emotion Regulation

Emotion regulation skills were assessed using the Emotion Regulation Skills Questionnaire (*ERSQ*; German version: Berking and Znoj, 2008). The ERSQ is a self-report instrument that includes 27 items and utilizes a 5-point Likert-type scale (1 = *not at all* to 5 = *almost always*) to assess adaptive emotion regulation skills (Berking and Znoj, 2008). However, in the present study, a four-point scaling was used, as also indicated in the validation paper by Berking and Znoj (2008). The ERSQ assesses nine specific ER skills (awareness, sensations, clarity, understanding, acceptance of aversive emotions, resilience, self-support in distressing situations, readiness to confront distressing situations, and modification) with subscales composed of three items each. The items are preceded by the stem, "Last week . . .." Sample items include: "I paid attention to my feelings" (awareness); "my physical sensations were a good indication of how I was feeling" (sensations); "I was clear about what emotions I was experiencing" (clarity); "I was aware of why I felt the way I felt" (understanding); "I accepted my emotions" (acceptance of aversive emotions); "I felt I could cope with even intense negative feelings" (resilience); "I did what I had planned, even if it made me feel uncomfortable or anxious" (readiness to confront distressing situations); and "I was able to influence my negative feelings" (modification). Emotion regulation was successfully assessed by averaging all items to compute a total score (Berking and Znoj, 2008). In the present study the internal consistency of the total ERSQ scale score was excellent (α_{t1} = 0.91). The subscales' corrected item-total correlation achieved acceptable values (r_{it} = 0.37–0.78), equally the respective internal consistencies (α = 0.63–0.87). The test-retest reliability for the total ERSQ scale score was r_{tt} = 0.55.

Statistical Analysis

The descriptive and inferential statistical analyses of the data were carried out, after the transformation of the protocols from SoSci Survey (Leiner, 2020) on the basis of the corresponding data matrix. All descriptive and inferential statistical analyses were conducted using IBM SPSS® 22.0 for Mac OSX (IBM Corp., 2013).

Treatment Efficacy

For the analysis of hypothesis 1, thus, to examine whether general ER skills were increased significantly among the treated IG as compared to the untreated WLC, the changes in ERSQ scores over time due to the treatment (within group effect) and the differences between the conditions at t2 (between group effect) were tested using a MANOVA. To test hypothesis 2 and to assess the treatment efficacy, a two-way (2 × 2) mixed rmANOVA was calculated, with *time* (t1 vs. t2) as the within-subjects factor, *treatment* (IG vs. WLC) as the between-subjects factor and *procrastination* as the dependent variable. The advantage of this method is that it allows the analysis of interactions of several factors on the dependent variable, besides the analysis of the main effect. To answer hypothesis 2 the outcome values of the dependent variable (GPS-K mean scores) of the IG group were compared with those of the WLC group. In addition, effect sizes (Cohen's *d*) were calculated to estimate the within effect (t2 – t1 for each group) and the between effect (IG vs. WLC at t2) of the training. Accordingly, follow-up independent sample *t*-tests were used to analyze whether the two groups significantly differed in procrastination scores at baseline and at post-measurement. Follow-up paired sample *t*-tests were used to test the reduction from t1 to t2 in procrastination scores for significance in both groups.

Mediation Analysis

For the analysis of hypothesis 3, thus, to investigate whether the expected treatment effect could be attributed toward the enhancement of general ER skills, a mediation analysis, according to Hayes (2018), was performed, as the causal steps approach by Baron and Kenny (1986) has been scientifically criticized due to low statistical power and the non-direct testing of one indirect effect (Preacher and Hayes, 2004; Hayes, 2009; Rungtusanatham et al., 2014). Therefore, to validly test the mediation effect and draw conclusions concerning the hypotheses, this study relied on the significance of indirect effects (the effect of the mediator). Indirect effects were estimated by calculating a point-estimate for the product of a × b and interval-estimates (*CI*; confidence interval; Hayes, 2018). The mediation analysis was conducted using PROCESS macro (2.16.3) by Hayes (2018), which applies linear regression to detect unstandardized path coefficients for total, direct, and indirect effects by making use of ordinary least squares. The bootstrap-based test provides the advantage of requiring the smallest sample size, providing the best power (Fritz and MacKinnon, 2007), and not requiring normally shaped sampling distributions (Preacher and Hayes, 2004).

RESULTS

Treatment Efficacy

To examine whether the ER intervention significantly increased general ER skills among the IG as compared to the WLC, a MANOVA was calculated. Accordingly, a preliminary calculation of the difference in ERSQ scores (t2–t1) was carried out and subsequently tested with a one-way MANOVA. In line with hypothesis 1, the MANOVA indicated a significant increase for the total scale score in general ER skills among the IG from pre- to post-measurement in comparison to the WLC ($F_{1,146}$ = 26.987, $p < 0.001$, partial η^2 = 0.16). **Table 1** depicts the means and standard deviations of the ERSQ score for the baseline (t1) and post-measurement (t2) for both groups as well as the test statistics and effect sizes. Regarding the within group effect sizes, the increase in general ER skills from t1 to t2 was considered large within the IG (d_{within} = 0.9) and very small within the WLC (d_{within} = 0.06). The size of the between group effect at post-measurement was medium ($d_{between}$ = 0.48).

To test hypothesis 2, and thereby examine the changes in procrastination scores from t1 to t2 among both groups, time as the within-subjects factor and treatment as the between-subjects factor were included in the two-way (2 × 2) mixed rmANOVA.

TABLE 1 | Means, standard deviations, and test statistics of the procrastination scores (GPS-K) and ER skills scores (ERSQ) for the intervention (IG) and the wait-list control group (WLC).

	WLC (n = 75)		IG (n = 73)		Test statistics		
Scale	***M*t1 (*SD*)**	***M*t2 (*SD*)**	***M*t1 (*SD*)**	***M*t2 (*SD*)**	***F*(1,146)**	***p***	**η^2**
GPS-K	2.85 (0.66)	2.70 (0.67)	2.81 (0.63)	2.43 (0.53)	14.498	<0.001***	0.09
ERSQ	3.03 (0.45)	3.06 (0.49)	2.89 (0.48)	3.26 (0.33)	26.987	<0.001***	0.16

*N = 148. M, Mean; SD, Standard deviation; η^2, Eta-square; p, p-value; GPS-K, General Procrastination Scale; ERSQ, Emotion Regulation Skills Questionnaire. ***$p < 0.001$.*

Both the main effect for the factor time ($F_{1,146}$ = 72.868, $p < 0.001$, partial $\eta^2 = 0.33$) as well as the interaction term "time × treatment" ($F_{1,146}$ = 14.498, $p < 0.001$, partial $\eta^2 = 0.09$) were significant. The main effect of the within-subjects factor time had to be interpreted individually for each group and was therefore tested using follow-up paired sample t-tests. The results of the analysis comprising the means, standard deviations, and test statistics regarding both time and treatment are displayed in **Table 1**.

In both groups the procrastination mean scores (GPS-K) decreased over time. The results of the paired sample t-tests indicated that the reduction of procrastination from t1 to t2 was significant in both groups, with t_{74} = 3.593, p = 0.001 within the WLC and t_{72} = 8.172, $p < 0.001$ within the IG. The corresponding effect sizes for the reduction in procrastination were d_{within} = 0.41 within the WLC and d_{within} = 0.96 within the IG. To determine the actual treatment effect of the training, the effect of the IG was adjusted for the effect of the WLC (by subtracting the effect of the WLC) and expressed as a relativized effect. The relativized effect resulted in a total within effect of d = 0.55. **Figure 2** displays the reduction of procrastination behavior.

Considering the significant interaction effect, for the between-subjects effect, subsequent pairwise comparisons between the two groups at both measurement points were carried out. The independent sample t-test indicated that there was no significant difference in procrastination scores between the groups at baseline measurement, t_{146} = 0.381, p = 0.704, but that the IG and WLC significantly differed in procrastination scores at post-measurement, t_{140} = 2.764, p = 0.006, $d_{between}$ = 0.45. The between effect has a small magnitude and therefore indicated a small difference in the GPS-K scores between the IG and WLC at post-measurement.

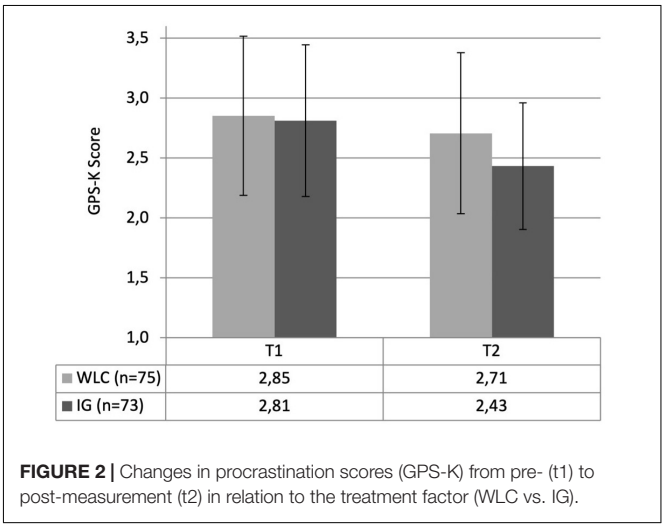

FIGURE 2 | Changes in procrastination scores (GPS-K) from pre- (t1) to post-measurement (t2) in relation to the treatment factor (WLC vs. IG).

Analysis of Mediation

In this section, a mediation analysis, in line with hypothesis 3, is reported to test the mediating influence of general ER skills from the treatment variable on the changes in procrastination scores at t2. The mediation analysis was performed based on model 4, according to Hayes (2018). For the analysis, the treatment condition (IG vs. WLC) was used as the independent variable, procrastination scores at t1 as the covariate, the differences in ERSQ scores between t2 and t1 ($ERSQ_{t2}$ – $ERSQ_{t1}$ = ΔERSQ) as the mediator variable, and procrastination at t2 as the dependent variable.

The path coefficient for the direct effect (c′) controlling the mediator ERSQ_t2-t1 resulted in, β = −0.175, p = 0.004, *95%-CI* [−0.294, −0.056], indicating a significant result. Both the a and b path displayed significant results (a: β = 0.338, $p < 0.001$, *95%-CI* [0.210, 0.466]; b: β = −0.203, p = 0.004, *95%-CI* [−0.294, −0.056]). The total effect (c), which represents a linear additive model consisting of the direct (c′) and indirect effect (the product of a × b), showed a small significant negative effect, β = −0.243, $p < 0.001$, *95%-CI* [−0.355, −0.132]. To validly test hypothesis 3, following contemporary scientific recommendations (Memon et al., 2018), this study relied on a 95% bias-corrected confidence interval based on 5,000 bootstrap samples, which revealed a significant indirect effect (β = −0.068, *95%-CI* [−0.125, −0.023]). Regarding the significant indirect effect (see Preacher and Hayes, 2004, for more details), the results indicated a significant mediation effect from treatment (IG vs. WLC) on procrastination scores at t2 via the increase in overall ER skills. **Figure 3** shows the respective mediation analysis with path significances according to Hayes (2018).

DISCUSSION

The present study first-time investigated whether the enhancement of general, task-unrelated ER skills through an online ER training significantly reduces subsequent procrastination behavior among university students. To examine the expected treatment effect adequately, this study was designed as a randomized controlled trial with two independent conditions, an intervention- (IG) and a wait-list control group

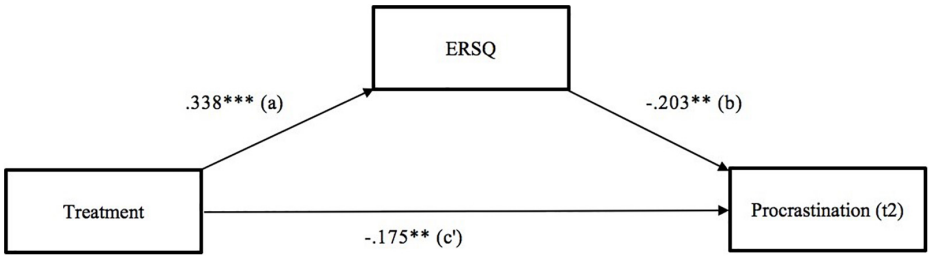

FIGURE 3 | Results of the mediation analysis with ΔERSQ as a mediator. Path analysis with unstandardized coefficients (β), according to Hayes (2018). All paths indicate significant effects. $N = 148$. $^{**}p < 0.01$; $^{***}p < 0.001$. a = path a, b = path b, c′ = path c′.

(WLC) and two measurement periods consisting of a baseline (t1) and a post-measurement (t2). Consistent with the main hypotheses, the results revealed that the applied ER training increased general ER skills among the IG significantly as compared to the WLC (H1) and reduced in a student sample the general tendency to procrastinate among the IG, as compared to the untreated WLC with a medium-sized effect (H2). In line with the third hypothesis, the results showed that the reduction of procrastination was mediated by the increase in general ER skills. Thus, it can be assumed that enhancing and fostering ER skills possesses the potential to reduce the postponement of intended tasks.

Procrastination represents a widespread phenomenon affecting almost all age groups (Ferrari et al., 2007; Steel, 2007) and especially up to 95% of the student population (Ellis and Knaus, 1977; Steel, 2007), potentially causing several mental health issues (e.g., Ferrari, 1991; Strongman and Burt, 2000), and negatively affecting indicators of performance and success (e.g., Gareau et al., 2018). Therefore, the objective of this study constituted the prevention of procrastination and its harmful consequences. Building on the assumption that preceding aversive emotions trigger subsequent procrastination behavior through the application of a dysfunctional ER strategy that enables the short-term avoidance of the antecedent aversive emotions (short-term mood repair; Sirois and Pychyl, 2013, 2016), the present research proposed that fostering general adaptive ER skills prevents the usage of procrastination as a dysfunctional ER strategy. In line with the hypotheses and preliminary findings of Eckert et al. (2016), the present results showed that the training of ER strategies enhancing general ER skills significantly reduced subsequent procrastination behavior from pre- to post-measurement among the IG, as compared to the untreated WLC, with a relativized medium-sized effect. From a theoretical point of view, the results provide empirical evidence for the prediction that the enhancement of adaptive ER skills reduces the employment of the dysfunctional ER strategy procrastination. When adaptive ER skills are acquired, they facilitate adaptive coping with preceding aversive emotions regarding a specific task.

Previous research by Eckert et al. (2016) has already highlighted that task-related ER strategies can prevent procrastination. Within their research, ER strategies were directly applied to overcome the aversive emotions associated with an unpleasant task. Adding onto a scarce body of scientific literature, the present study revealed that fostering general task-unrelated ER skills also exerts an influence on procrastination. The results, thus, provided empirical evidence for the indirect effect that general ER skills exert on procrastination. This suggests that acquiring new and enhancing existing ER skills, even in a relatively short intervention period of 9 weeks, can result in significant reductions in procrastination behavior among students. Therefore, online ER training interventions should be considered an effective measure for educational institutions to reduce procrastination and the associated adverse health outcomes. Consistent with the findings of Eckert et al. (2016), the between effect, indicating the difference of procrastination scores between the IG and the WLC at t2, displayed a small to medium effect size ($d_{between} = 0.45$). Similarly, a study by Rozental et al. (2015) showed that online-based self-help cognitive-behavior therapy resulted in moderate changes in procrastination scores, especially among the intervention group with the guidance of a therapist, but also among the unguided self-help group. Taking into consideration the various factors that can cause procrastination (Walsh and Ugumba-Agwunobi, 2002; van Eerde, 2003; Steel, 2007; Eckert et al., 2016), rather small effects were expected upfront. Nonetheless, given the detrimental consequences of procrastination, even smaller effects should not be underestimated, as marginal behavioral changes can exert strong influences on subsequent performance and well-being. In addition, practical relevance must always be interpreted in light of costs and expenditure. Given the cost-efficient online-based format of the applied ER training, the present intervention is highly suited for the practical context. Especially in view of the large proportion of students procrastinating on a regular basis (up to 95%; Steel, 2007), resulting in lower assignment- and course grades (Steel, 2007; Gareau et al., 2018), the present findings indicate that students would significantly procrastinate less through the implementation of ER trainings and accordingly enhance their procrastination-related impaired performance.

The results of the mediation analysis supported the assumption that the overall increase in ER skills mediates the relationship between group allocation and procrastination scores at post-measurement. Thus, the total increase in ER skills explained part of the treatment effect variance, as substantiated by a significant indirect effect. Accordingly, the interpretations that were derived regarding the first two hypotheses can be further substantiated by these findings, as they offer more scientifically sound conclusions. These conclusions incorporate

that the improvement in ER skills, induced by the training, accounts for the reduction in procrastination scores and thereby the observed treatment effect. These initial findings further strengthen the postulated prediction that the training itself enhances ER skills through the increase in adaptive ER skills, which subsequently allow adaptive coping with antecedent aversive emotions, ultimately aiding in the prevention of procrastination.

In line with the procrastination-health model (Sirois et al., 2003), procrastination bears the risk of causing poor health outcomes through a stress-related and a behavioral route. Adaptive ER is associated with decreased stress (Katana et al., 2019) and allows adaptive coping with aversive emotions instead of adducting to maladaptive impulsive behavioral coping strategies (Berking et al., 2012), such as procrastination or even eating unhealthy foods. Therefore, regarding the present findings, it can be assumed that procrastination interventions, enhancing the adaptive ER skills applied within this training manual, do not only significantly reduce subsequent procrastination, instead they additionally diminish and prevent the associated adverse health consequences of both the stress-related and behavioral route. In line with these assumptions, research has shown that aversive emotions do not only represent key antecedents of procrastination, but instead most often equally of various mental disorders (Liverant et al., 2008; Berking et al., 2011), given that they both rely on maladaptive ER processes (Berking and Stumpenhorst, 2012). Therefore, it becomes evident why chronic procrastination exerts such a strong negative influence on students' mental health and well-being through, e.g., increased levels of stress (Rice et al., 2012) or symptoms of depression (Essau et al., 2008; Flett et al., 2016). This research has shown that the enhancement of adaptive ER skills hinders aversive emotions from causing subsequent procrastination. Moreover, since maladaptive ER and the lack of adaptive ER skills is associated with many mental disorders, the acquisition of adaptive ER skills is suspected to additionally prevent the emergence of the associated adverse health effects of procrastination as well as other mental disorders based on impaired ER (Wirtz et al., 2013; Berking et al., 2014; Cloitre et al., 2019). Recent findings have already demonstrated that increasing ER skills can cause a reduction in depression (Eckert and Tarnowski, 2017; Berking et al., 2019) or improve the effect of cognitive behavioral therapy interventions for major depression (Berking et al., 2013). Especially taking into account that 75% of mental health issues are developed by the age of 25 and show an increase over the last decades (McManus et al., 2016), ER trainings should be considered a necessary intervention to diminish procrastination, its corresponding negative health consequences and prevent additional mental health issues.

Therefore, as a practical implication of these findings, educational institutions, especially universities, are encouraged to implement online-based trainings to enhance general ER skills. These trainings could allow a reduction in procrastination, symptoms of depression and an increase in well-being (Eckert and Tarnowski, 2017) and mental health (Berking et al., 2014). Especially, taking into account that the applied online ER training represents a cost-efficient and effective measure to reduce procrastination students should be provided with such trainings. The APOLLON University of Applied Sciences in Bremen in Germany already provides the German online version of the ER training "Stark im Stress" for all students for free and an English version is planned.

Thus, as students represent the social group that procrastinates most (Steel, 2007) and have a high risk for developing mental health issues (McManus et al., 2016), targeting ER skills to reduce procrastination, alleviate the respective health issues, and even promote buffering adaptive skills could provide a major step toward a healthier and more productive student population.

Taken together, the present findings highlight that the applied training of general ER skills (a) provided statistically significant increases in general adaptive ER skills, (b) significantly reduced the magnitude of subsequent procrastination behavior among the treated IG compared to the untreated WLC, which (c) was mediated by the overall increase in total ER skills. Adding onto preliminary findings, the present results replicate, albeit in part, the previous findings of Eckert et al. (2016) and beyond add insights on a more universal construct level. Conclusively, the value and major contribution of this study constitute that the present findings reveal unique first evidence indicating that the sole enhancement of general, non-task-specific ER skills significantly reduces subsequent procrastination. Therefore, these findings are highly valuable for current scientific literature, as they offer a more directed foundation for future research and for practical interventions aiming at diminishing the adverse effects of procrastination.

Limitations

Despite the scientific and practical value of this research, the present study holds certain limitations. These limitations ought to be taken into consideration when interpreting the present results and initiating further research.

As this study has a longitudinal design with two measurements, covariables might have influenced the present findings and lowered the internal validity, such as changes within participants due to maturation, historical events, and learning effects. Regarding historical events, especially the ongoing COVID-19 pandemic must be mentioned. However, as (a) both groups were equally affected by the circumstances and accordingly, potential confounds are equally distributed and (b) the training was initiated during the lockdown period, which might even have reduced potential confounds, as usual external factors were kept to a minimum, these limitations can be considered negligible. Additionally, the study is limited to two measurements, precluding predictions about effect stability. However, as a first step, this study revealed that enhancing general ER skills decreases procrastination. Nonetheless, future research is needed to investigate long-term effects. Another possible source of error constitutes the large number of psychology students within the present sample. Considering that psychology students are, on average, more conscientious and achievement-oriented, they are expected to generally procrastinate less, which might have affected the present results. However, the present sample can be considered rather diverse,

given that approximately 50% of the sample consisted of students of other faculties (economics and law, STEM fields, cultural, media and communication, and social sciences), as most psychological research is conducted exclusively on psychology students (Smart, 1966). The imbalanced gender ratio, with 75% female participants, however, does provide a limitation, especially as several studies have indicated that procrastination appears to be more represented among male students (e.g., Prohaska et al., 2000; Balkis and Duru, 2009; Kahn et al., 2014). The homogenous student sample does, on the one hand, increase the internal validity, however, limits the external validity. Therefore, generalizing predictions about other populations should be considered with caution, as generalizations from students to the general public can bear difficulties (Hanel and Vione, 2016). Additionally, self-selection biases (Lavrakas, 2008) might have affected the present results, as participants voluntarily signed up for this study. The non-existence of blinding of participants could account for further biases and could have functioned as placebo since participants were aware of the research object (the alleviation of procrastination through the training). Unfortunately, this study did not include an active control group with the administration of a placebo. Accordingly, effects due to placebo cannot be excluded. Another potential source of error constitutes the self-report measurement instrument of the dependent variable (procrastination) and the mediator variable (emotion regulation skills), which might encompass response biases (Del Boca and Noll, 2000). Nonetheless, it must be acknowledged that both questionnaires are validated and represent convergent and discriminant valid measures of the examined constructs (GPS-K; Klingsieck and Fries, 2012; ERSQ; Berking and Znoj, 2008). Furthermore, it should be noted that the randomization was only partially successful as there were significant distribution differences regarding gender and course of studies between the treatments. However, as the largest groups (psychology and business students) were distributed evenly, it can be assumed that the course of study allocation difference had no distorting influence on the results. Moreover, as they were due to randomization, they can be considered negligible.

Future Research

As already indicated in the section "Limitations," further research is necessary to substantiate the present findings and overcome the appeared restrictions. First, considering the scarce prior research within the field of ER in relation to procrastination, further replicating scientific work is needed to confirm and evaluate the detected treatment and mediation effects. Especially, replicative RCTs with active control groups should be considered to preclude that the findings confounded with a placebo. The present results are encouraging yet should be replicated with other samples, especially representative adult samples, to ensure the practical value of ER interventions in the prevention of procrastination beyond the educational context. Effects among adult populations would allow a transfer of the present implications onto a different population, and therefore, the opportunity to reduce procrastination within a broader target group at a more generalizing population level. Further research should investigate the effects of different ER skills trainings on procrastination to examine potential differences between trainings and to ensure the independence of the findings from the selected training program. The present results suggest that as maladaptive coping with preceding negative affect is reduced, and adaptive coping is enhanced by improving adaptive ER skills, subsequent procrastination diminishes. Since maladaptive coping mediates the relationship between procrastination and its associated negative health consequences (e.g., Sirois and Tosti, 2012; Sirois and Kitner, 2015), further research should validate the prediction that the enhancement of ER skills permits a reduction of procrastination's related negative health consequences through the enhancement of adaptive coping. It follows logically that future research should investigate adaptive coping and potential improvements in subsequent health indicators, to test whether the improvements in the procrastination-related impaired health indicators are attributable toward the increases in adaptive coping through the enhancement of adaptive ER skills. Additionally, alterations in performance indicators such as course grades or work productivity should longitudinally be assessed to further evaluate the practical value of ER training interventions. Conclusively, the present study provides a seminal base for future studies on the prevention of procrastination.

CONCLUSION

Taken together, considerable progress has been made with the present study. The present findings add onto a scarce yet growing body of literature supporting previous assumptions about the interrelationship of ER skills and procrastination. Most strikingly, the present results provide first-time novel insights on a more universal construct level. This study has contributed toward enhancing our understanding of how the broad constructs of ER and procrastination are related to each other, showing that the exclusive enhancement of general adaptive ER skills significantly reduces procrastination behaviors. Moreover, this research precisely clarified through subsequent significant mediation analyses of ER skills which facets of the broad construct ought to be enhanced to significantly reduce procrastination behavior. Even though further empirical work needs to be initiated to replicate the present findings and overcome the limitations, the present results notably contribute to our current knowledge of procrastination as a dysfunctional ER strategy and depict an essential step toward overcoming the phenomenon.

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 Leuphana University of Lüneburg. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LS executed and administered the study, wrote the first version of the manuscript, and composed the final version in cooperation with ME. VS corrected and advised regarding stress regulation. MS corrected and advised regarding ER. ME developed the online training SIS, supported the development of the study design, and composed the final version of the manuscript in cooperation with LS.

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Effect of Self-Efficacy on Bedtime Procrastination Among Chinese University Students: A Moderation and Mediation Model

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Bedtime procrastination (BP) is generally considered to be a maladaptive behavior. However, BP may be an adaptive fast LH strategy within the LH framework, and further, personal beliefs about their abilities and resources promote this fast LH strategy. Here, the present study addressed this idea, focusing on the effect of self-efficacy on BP, the mediation of harm avoidance (HA), and the moderation of novelty seeking (NS). Data from 552 Chinese university students (205 men and 347 women) were analyzed using SPSS 25.0 and SPSS PROCESS Macro. Results indicated that HA partially mediates the relationship between self-efficacy and BP. Main interactional effects have been observed when NS is introduced in the model as a moderator. Implications and limitations of the study and suggestions for further study are discussed.

Keywords: self-efficacy, bedtime procrastination, harm avoidance, novelty seeking, tridimensional personality questionnaire

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INTRODUCTION

Sleep serves important functions and is essential for physical and mental health (Banks and Dinges, 2007). Insufficient sleep leads to a lot of adverse consequences, such as low working efficiency (Kessler et al., 2011), poor academic performance (Jiang et al., 2011), a reduction in optimism and sociability (Haack and Mullington, 2005; Lemola et al., 2011), mental stress, depressed mood, and anxiety (Da Costa et al., 2010). An important behavioral factor held responsible for insufficient sleep in the general population is bedtime procrastination (BP), a phenomenon defined as "going to bed later than intended, without having external reasons for doing so" (Kroese et al., 2014, 2016). BP was found to be positively correlated with short sleep duration and poor sleep quality among Chinese (Zhang and Wu, 2020) and Polish (Herzog-Krzywoszanska and Krzywoszanski, 2019) university students. Further, university students have higher BP scores than non-student groups (Herzog-Krzywoszanska and Krzywoszanski, 2019). However, the psychological mechanisms of BP are still not fully understood. BP is well-studied from a self-regulation perspective. For example, BP is supposed to be a self-regulation problem with a poor ability to resist temptations (Kroese et al., 2016). Consistent with this perspective, BP has been found to be negatively associated with self-regulation (Kroese et al., 2014, 2016) and positively related to the level of depleted self-regulatory resources (Kamphorst et al., 2018). Further, people who think willpower is limited and easily depleted are more likely to procrastinate at bedtime following a stressful day, but not less stressful days (Bernecker and Job, 2020). That is to say, a lack of self-regulation skills or psychological resources leads to a failure of self-regulation, which in turn leads to BP. In this perspective, BP

is maladaptive because it will lead to insufficient sleep which in turn results in the aforementioned adverse consequences in the long term. However, the evolutionary origin and function of BP within the life history (LH) framework has not been investigated, and BP might be adaptive within the LH framework.

Life history theory has been developed to explain differences in energy and time allocation patterns between and within species (Sng et al., 2017). All living organisms have limited resources. How they allocate their limited resources is critical to the survival and continuation of species. Their resource allocation strategies often change based on an assessment of the environmental constraints. In a predictable living environment, it is cost-effective to plan and work for higher future rewards. Therefore, humans and animals' cognition and behavior are biased toward the slow LH strategy and their cognition and behavior tend to be more future- than present-oriented. This is to say, they prefer the behaviors that are likely to have high returns in the future but have little or no immediate benefit. Within the same framework, people with slow LH are expected to be future-oriented and not procrastinate (Chen and Chang, 2016). On the contrary, when the future is uncertain and less predictable, there is a low probability that the investment will pay off in the future. Therefore, a fast strategy is more adaptive, wherein organisms will show an increased focus on the present and discount the future. With the same logic, fast LH people are expected to be procrastinators because investing in the present is the most profitable compared with the future (Chen and Chang, 2016).

The same logic seems to also apply to BP. For example, a recent study found that people who believed that willpower was limited and easily depleted (limited theory) were more likely to procrastinate their bedtime after a stressful day than those who considered willpower as a non-limited resource (non-limited theory), whereas there was no difference between them after a less stressful day (Bernecker and Job, 2020). The author argued that since sleep may be the best way to recover, people with a limited vs. non-limited theory should be more concerned with restoring their resources and going to bed on time after a stressful day. However, they ironically procrastinated more at bedtime. Within the LH framework, it seems that BP is a fast LH strategy for people with a limited theory after a stressful day, who prefer immediate relaxation to long-term benefits. People with a limited theory believe that their willpower resources are easily depleted and that they need to be restored, for instance, by taking a break or eating, to be available again. Besides, people with a limited vs. non-limited theory are expected to be more exhausted from unpleasant tasks following a demanding day (Bernecker and Job, 2015). BP serves the adaptive function of taking an immediate break from the challenge and avoiding serious negative consequences and death from exhaustion when there is no more psychological resource for ongoing and upcoming challenges.

On the other hand, the results of this study also suggested that personal beliefs about their abilities and resources promote the fast LH strategy. Since these beliefs can influence their assessment of the controllability of the environment. For example, unpredictability schemas in college students are associated with lower self-efficacy (Ross et al., 2016), the belief in one's competence to cope with a broad range of stressful or challenging demands (Bandura, 1986). Further, people with a fast LH strategy have a lower self-efficacy score than slow LH strategy individuals when they are consumers (Hidding and Fennis, 2018). Therefore, low self-efficacy is expected to promote the fast LH strategy, and self-efficacy might be negatively correlated with BP (H1).

In a stressful situation, low self-efficacy increases subjective assessments of environmental unpredictability (Ross et al., 2016). Fear of such unpredictability will lead individuals to over-prepare for or escape from such situations. However, at the same time, due to low self-efficacy, the need for over-preparation makes individuals face greater challenges and exhaustion, which in turn further increases the subjective experience of unpredictability and uncontrollability. In this context, escaping from stressful situations and immediately letting oneself relax becomes the best option at that moment. Therefore, fear and avoidance of environmental unpredictability are expected to mediate the effect of self-efficacy on BP. The harm avoidance (HA) in the tridimensional personality questionnaire (TPQ) paints a good picture of such fear and avoidance tendencies by four facets: HA1 (anticipatory worry), HA2 (fear of uncertainty), HA3 (shyness with strangers), and HA4 (fatigability and asthenia). More importantly, HA is especially associated with serotonin (Cloninger, 1986), an important neurotransmitter involved in negative emotions, such as depression and anxiety. Further, convergent lines of evidence suggest a negative correlation between self-efficacy and negative affect in undergraduate students (Ashby and Kottman, 2000; Leganger et al., 2000) and Chinese adolescents (Huang and Zhang, 2010), while, negative affect was positively associated with a fast LH strategy (Figueredo et al., 2007; Sefcek, 2007). In addition, a recent study found a positive relation between BP and negative affect, and the effect of self-compassion on reducing BP was mediated by lower negative affect but not higher positive affect (Sirois et al., 2019). Based on these data, we assume that HA mediates the effects of self-efficacy on BP (H2).

Chinese college students are usually undergoing a learning and growth period that is completely different from high school. In high school, they are exposed to the strict disciplines or supervision imposed by family members and teachers; while these supervisions are no longer in the college, making self-discipline crucial for them (Geng et al., 2018). This is the first time that they have faced personal and academic challenges independently. On the other hand, they are relatively inexperienced in independence and have not yet reached psychosocial maturity, especially the ability to restrain themselves in the face of emotional, exciting, or risky stimuli (Icenogle et al., 2019). Therefore, the next question was whether the relationship between self-efficacy and BP might be moderated by poor self-discipline processes facing emotional, exciting, or risky stimuli, such as novelty seeking (NS). NS in TPQ refers to a tendency to respond to novel stimuli with excitement. It strongly resembles sensation seeking (Zuckerman and Cloninger, 1996). Several studies revealed that sensation seeking was positively associated with later bedtime preference, such as eveningness (sometimes labeled "owls") in young adults (Tonetti et al., 2010;

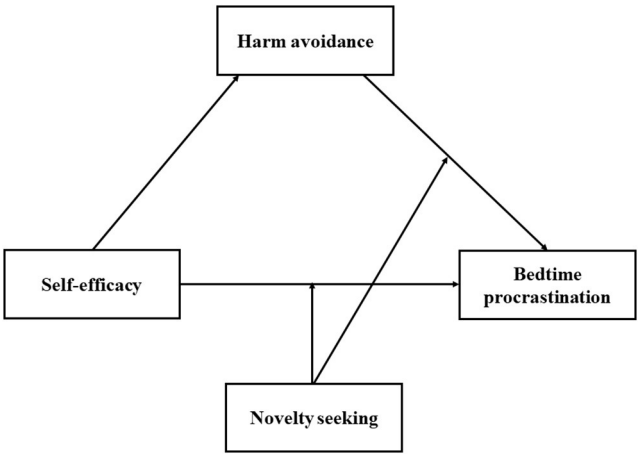

FIGURE 1 | Hypothesized moderated mediation model to predict bedtime procrastination.

(Antúnez et al., 2014; Geng et al., 2018)). Further, NS is strongly linked with the defect in the probability and delay discounting task (Zheng et al., 2019), which is related to the present-oriented behavior and cognition of the fast LH strategy. Therefore, we hypothesize that NS moderates both the direct effect of self-efficacy on the BP (H3) and the indirect effect of self-efficacy on the BP (H4), which is mediated by HA.

Together, we aim to examine these four following hypotheses (as shown in **Figure 1**):

H1: Self-efficacy is negatively related to BP.

H2: HA mediates the effect of self-efficacy on BP.

H3: NS moderates the direct effect of self-efficacy on the BP.

H4: NS moderates the indirect effect of self-efficacy on the BP mediated by HA.

MATERIALS AND METHODS

Subjects

This research was approved by the ethics committee of Guizhou Medical University. The data were collected through Wen Juan Xing, an online survey tool. In total, 600 Chinese college student volunteers were recruited from five universities located in Guizhou, Jiangxi, Henan, Shandong Province, and Shanghai, respectively. An anonymous self-report questionnaire was distributed to volunteers during their elective courses. All participants gave informed consent and had about 20 min to complete every questionnaire item. To ensure the quality of the data, we excluded the data of subjects whose completion time was <300 s. Finally, data from 552 participants (205 men and 347 women) with an age range of 18–23 years (M = 19.22 years, SD = 0.643 years) were included in the analysis.

Measures

BP Scale (BPS)

Bedtime procrastination was assessed by a Chinese version of the 9-item BP scale (Xiao-han et al., 2021) where items were scored on a 5-Likert point scale, 1 = almost never, 5 = almost always. The Cronbach's coefficient in this study was 0.831.

The General Self-Efficacy Scale (GSES)

General self-efficacy (GSE) was measured by a 10-item general self-efficacy scale (GSES) designed to assess optimistic self-beliefs to cope with a variety of difficult demands in life (Schwarzer and Jerusalem, 1995). The Chinese version of the GSES was used (Cai-kang et al., 2001). Items were scored on a 5-Likert point scale, 1 = almost never, 5 = almost always. Cronbach's alpha in the present sample was 0.877.

Tridimensional Personality Questionnaire (TPQ)

The NS and HA were evaluated by a Chinese version of the 100-item TPQ, which is a true/false questionnaire (Cai-kang et al., 2001). The NS dimension is composed of four facets: NS1 (exploratory excitability), NS2 (impulsivity), NS3 (extravagance), and NS4 (disorderliness). The HA dimension includes four facets: HA1 (anticipatory worry), HA2 (fear of uncertainty), HA3 (shyness with strangers), and HA4 (fatigability and asthenia), while the RD also has four facets: RD1 (sentimentality), RD2 (persistence), RD3 (attachment), and RD4 (dependence). The Cronbach's coefficient in the current study was 0.901.

Data Analysis

Data collected in this study were processed using SPSS 25.0. Following initial correlation analysis, we used SPSS PROCESS Macro Model 4 to examine whether HA mediates the association between self-efficacy and BP (H2). Bootstrapped confidence interval (*CI*) (5,000 bootstrap samples) for the indirect effect was obtained. Then, we used model 15 of the PROCESS to assess the moderated mediation model (H3 and H4, as shown in **Figure 1**).

RESULTS

The Descriptive Statistics and Correlations for the Variables

Table 1 presents the descriptive statistics and correlations for the variables in the present study. Self-efficacy correlated strongly with HA ($r = -0.43$, $p < 0.01$) and BP ($r = -0.33$, $p < 0.01$), and did not relate with NS ($r = -0.08$, $p > 0.05$). HA was positively correlated with BP ($r = 0.22$, $p < 0.01$) and did not relate with NS ($r = -0.07$, $p > 0.05$). NS was positively correlated with BP ($r = 0.29$, $p < 0.01$).

Hypothesis Test

We expected that self-efficacy is negatively related to the BP and that HA would mediate (H2), while NS moderate the direct association between self-efficacy and BP (H3) and the indirect effect of self-efficacy on the BP mediated by HA (H4). First, to test the mediation hypothesis (H2), model 4 of PROCESS macro for SPSS (Hayes, 2017) was used. The specifications of this model can be seen in **Table 2**. Results show that self-efficacy is negatively and significantly related to HA ($R^2 = 0.19$; $p < 0.001$). Self-efficacy is negatively and significantly related with BP ($R^2 = 0.11$; $p < 0.001$), which supports H1. After controlling for gender, grade and age, the mediator and dependent variable

TABLE 1 | Descriptive statistics and correlations of study variables.

Variables	M	SD	1	2	3	4
1. Self-efficacy	32.92	5.37	–			
2. Harm avoidance	51.60	5.90	−0.43**	–		
3. Novelty seeking	46.46	4.21	−0.08	−0.07	–	
4. Bedtime procrastination	29.27	6.97	−0.33**	0.22**	0.29**	–

*N = 552, **p < 0.01.*

TABLE 2 | Mediation analysis for self-efficacy, harm avoidance (HA), and bedtime procrastination (BP).

	β	SE	t	p
Mediator variable model				
Constant	57.20***	10.89	5.25	< 0.001
Gender	0.21	0.48	0.43	0.67
Age	0.53	0.58	0.92	0.36
Grade	−0.23	0.52	−0.44	0.66
Self-efficacy	−0.48***	0.04	−11.06	< 0.001
Dependent variable model				
Constant	19.18	13.59	1.41	0.16
Gender	0.43	0.59	0.73	0.47
Age	0.83	0.71	1.18	0.24
Grade	−0.55	0.64	−0.86	0.39
Self-efficacy	−0.36***	0.06	−6.12	< 0.001
Harm avoidance	0.12*	0.05	2.21	< 0.05
	β	**Boot SE**	**BootLLCI**	**BootULCI**
Total effect	−0.42	0.05	−0.52	−0.31
Direct effect	−0.36	0.06	−0.48	−0.24
Indirect effect	−0.06	0.02	−0.10	−0.01

*N = 552. LL, low limit; CI, confidence interval; UL, upper limit. Gender was dummy coded. Bootstrap sample size = 5,000. *p < 0.05 and ***p< 0.001.*

TABLE 3 | Moderated mediation analysis for self-efficacy, HA, BP, and novelty seeking (NS).

	β	SE	t	p
Mediator variable model				
Constant	−10.30	10.73	−0.96	0.34
Gender	0.21	0.48	0.43	0.67
Age	0.53	0.58	0.92	0.36
Grade	−0.23	0.52	−0.44	0.66
Self-efficacy	−0.48***	0.04	−11.06	< 0.001
Dependent variable model				
Constant	12.90	12.44	1.04	0.30
Gender	0.24	0.56	0.42	0.67
Age	0.88	0.67	1.31	0.19
Grade	−0.72	0.61	−1.19	0.24
Self-efficacy	−0.33***	0.06	−5.78	< 0.001
Harm avoidance	0.16**	0.05	3.25	< 0.01
Novelty seeking	0.46***	0.06	7.09	< 0.001
Self-efficacy × Novelty seeking	0.03*	0.01	2.20	< 0.05
Harm avoidance × Novelty seeking	−0.01	0.01	−0.83	0.41
	β	**Boot SE**	**BootLLCI**	**BootULCI**
Conditional direct effect analysis				
M – 1SD (−4.20)	−0.45	0.08	−0.62	−0.29
M (0.00)	−0.33	0.06	−0.44	−0.22
M + 1SD (4.20)	−0.20	0.08	−0.35	−0.05
Conditional indirect effect analysis				
M – 1SD (−4.20)	−0.10	0.04	−0.17	−0.02
M (0.00)	−0.08	0.03	−0.13	−0.03
M + 1SD (4.20)	−0.06	0.03	−0.12	0.01

*N = 552. LL, low limit; CI, confidence interval; UL, upper limit. Gender was dummy coded. Bootstrap sample size = 5,000. *p < 0.05, **p < 0.01, and ***p < 0.001.*

models show that self-efficacy negatively predicted HA ($\beta = -0.48$, $p < 0.001$), HA positively predicted BP ($\beta = 0.12$, $p < 0.05$), and self-efficacy negatively predicted BP ($\beta = -0.36$, $p < 0.001$). The resampling procedure (5,000 bootstrap samples) indicates a significant indirect effect since the *CI* at 95% does not include the value of zero (as shown in **Table 2**). These results indicated a significant mediating effect of HA in the relationship between self-efficacy and BP. H2 is confirmed. Our mediation model explains 14.3% of the BP.

To test H3 and H4, we performed model 15 of the PROCESS macro for SPSS (Hayes, 2017). The specification of this model can be seen in **Table 3**. The results showed that the interaction effect of HA and NS on BP was insignificant ($\beta = -0.01$, $p = 0.41$, as shown in **Table 3**). Therefore, H4 was not supported. That is to say, the magnitude of the indirect effect of self-efficacy on the BP mediated by HA did not change according to NS. The results, on the other hand, revealed a significant interaction effect of self-efficacy and NS on BP ($\beta = 0.03$, $p < 0.05$). As can be seen from the conditional direct effect analysis, three conditional direct effects were negatively and significantly different from zero. Thus, H3 was supported. Namely, the effect of self-efficacy on BP changed according to NS (as shown in **Figure 2**). The final model is shown in the **Figure 3**.

DISCUSSION

Bedtime procrastination, an important behavioral factor responsible for insufficient sleep in the general population, is an emerging field of procrastination research in recent years

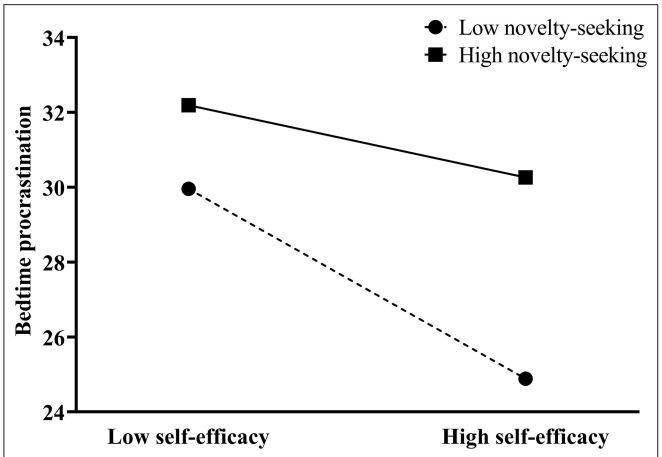

FIGURE 2 | The moderation effect of novelty seeking on self-efficacy to bedtime procrastination.

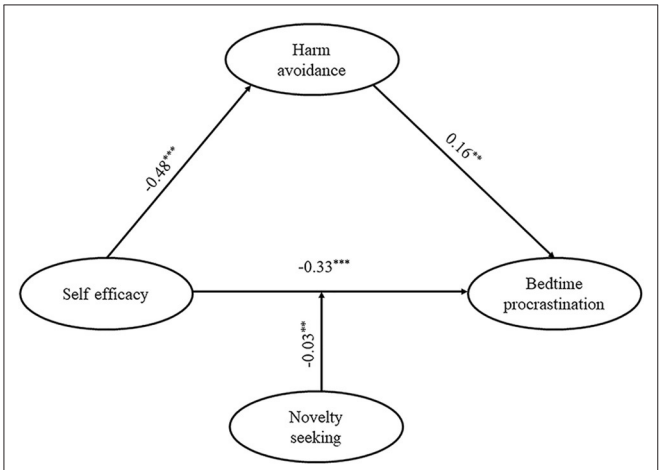

FIGURE 3 | Theoretical research model with standard coefficients.

(Kroese et al., 2014, 2016). Although various causal factors of BP research have been investigated, the mechanisms underlying BP appear to be more complex than expected and less clear than other forms of procrastination. BP is generally considered to be a maladaptive behavior. However, a recent study found that stress has a moderate role in the relationship between BP and beliefs about willpower (Bernecker and Job, 2020), suggesting that BP might be a fast LH strategy and serve an adaptive function within the LH framework, and that personal beliefs about their abilities and resources promote this fast LH strategy. Here, we further addressed this idea, focusing on the effect of the self-efficacy on BP, the mediation of HA, and the moderation of NS.

First, we confirm that self-efficacy is an important factor negatively and significantly related with BP. This is in line with previous studies showing a negative correlation between self-efficacy and procrastination (Steel, 2007; Wäschle et al., 2014) and sleep problems (Przepiórka et al., 2019).

Second, we identified a partially mediated role of negative affect on the relationship between self-efficacy and BP. The less self-efficacy, the more negative affect (HA) and finally results in more BP. This was consistent with the result of previous research, where a positive relation between BP and negative affect was found, and the effect of self-compassion on reducing BP was mediated by lower negative affect but not higher positive affect (Sirois et al., 2019). According to LH theory, the negative effect might promote the fast LH strategy. Sleep appears to be the best way to recover, however, its restorative effects are not experienced until the next morning, while the relaxing effect of leisure and social activities before going to bed (Chung et al., 2020) can be experienced immediately. Thus, prolong relaxing activities into the night might be the best recovery way for bedtime procrastinator within the LH framework.

Finally, this study explores the facilitating effect of the direct association between self-efficacy and BP and the indirect effect of self-efficacy on the BP mediated by HA. Our results showed that NS did not moderate the indirect effect of self-efficacy on the BP mediated by HA. On the other hand, a significant interaction between self-efficacy and NS was found. High novelty seekers have high BP regardless of self-efficacy; while for people with low NS, lower self-efficacy was associated with higher BP. These results suggest that it might be a potentially effective intervention to improve the self-efficacy for the bedtime procrastinators with low NS, but not for those with high NS.

This study makes several contributions. At a theoretical level, it improves our understanding of the mechanisms of BP. It might be an active adaptive strategy within the LH framework. The stress-related personality traits, such as self-efficacy, the HA, and NS, interact with each other to influence BP. At a practical level, this study shows that negative affect, such as HA, might be a target of BP intervention; besides, clients' novel seeking types need to be considered when formulating self-efficacy interventions for BP.

The present study had some limitations. First, it was a cross-sectional design which does not allow establishing the causality of mediation (Zapf et al., 1996). Second, we collected a low number of sociodemographic variables, which limits the possibility to explore how the moderation and mediation model works with different groups of people. We only collected three demographic variables, such as age, gender, and grade, limiting the possibility to explore whether the mediation model work with different groups.

CONCLUSION

A lower sense of self-efficacy in dealing with external stressful events leads to BP. HA mediated and NS moderated the effect of self-efficacy on the BP.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of Guizhou Medical University. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

XM and CL designed and performed the research. XM, CL, and HS analyzed the data. CL wrote the manuscript. XM, HS, and CL revised the manuscript. All authors contributed to the article and approved the submitted version.

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