Predicting Procrastination in Everyday Life

From Individual Differences in Procrastination Tendencies to Intraindividual Variability in Momentary Task Appraisal

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Preface

Portions of this dissertation have been derived from different studies and research collaborations. Studies that were planned and conducted earlier have influenced the work of later phases. The work presented in this dissertation builds on each other, although the studies included were not designed, conducted, and completed in the chronological order in which they are presented. **Chapter 1** provides a general introduction to the current state of research that has informed the empirical research presented in this dissertation. Subsequent parts of this dissertation (Chapter 2, Chapter 3, Chapter 4) were written as empirical research articles submitted for publication in scientific journals. These chapters are related to each other in terms of content, but can also be read and understood as independent units. Parts of this work have already been published (Chapter 3) or have been submitted for publication and are currently under review (Chapter 2 and Chapter 4). [1]

Chapter 2. Wieland, L. M., Ebner-Priemer, U. W., Limberger, M. F., & Nett, U. E. (2021). Predicting delay in goal-directed action: An experience sampling approach uncovering within-person determinants involved in the onset of academic procrastination behavior. *Manuscript submitted for publication.*

Chapter 3. Wieland, L. M., Grunschel, C., Limberger, M. F., Schlotz, W., Ferrari, J. R., & Ebner-Priemer, U. W. (2018). The ecological momentary assessment of procrastination in daily life: Psychometric properties of a five-item short scale. *North American Journal of Psychology, 20* (2), 315-339.

Chapter 4. Wieland, L. M., Hoppe, J. D., Wolgast, A., & Ebner-Priemer, U. W. (2021). Task ambiguity and academic procrastination: An experience sampling approach. *Manuscript submitted for publication*.

The order in which these chapters are presented does not correspond to the chronological sequence of their submission to the respective journals. The content of the articles that have been already published or submitted for publication has not been changed in any way. However, in favor of a uniform layout, editorial adjustments were made to integrate the articles into the present dissertation.

[1] Chapter 2 and Chapter 4 have been published after submission of this dissertation. A reference to the final publication (including modifications made in the course of the peer-review process) can be found at the beginning of these chapters.

Finally, **Chapter 5** provides a general discussion of the research findings, highlights implications for future research, and outlines prospective fields of application. The attentive reader will notice some overlap between the chapters, some content will be repeated as the work presented in Chapter 2, Chapter 3 and Chapter 4 followed a common line of reasoning. Finally, the reader will note that each chapter contains a separate section for footnotes, references, and appendices. The reader is kindly asked to excuse any repetitions that result from these circumstances.

Summary

Procrastination is typically defined as an irrational behavior characterized by unnecessarily delaying the completion of important tasks, contrary to one's original intention, despite knowing that doing so could be to one's detriment (cf. Klingsieck, 2013; Simpson & Pychyl, 2009; Steel, 2007). Taking a trait-based perspective, research has consistently shown that students' self-reported procrastination tendencies are closely related to individual differences in conscientiousness, neuroticism, or impulsivity (Ferrari & Emmons, 1995; Lee et al., 2006; Schouwenburg & Lay, 1995; Watson, 2001). At the same time, procrastination can be understood as a task-specific avoidance behavior resulting from a failure of self-regulation (DeWitte & Lens, 2000; Howell et al., 2006; Steel et al., 2018). An effort to understand the occurrence of procrastination behavior as a failure of self-regulation would require to consider that individuals' self-regulatory capacities — their motivational and volitional determinants — may change over time depending on task- or context-specific influences (see Dietrich et al., 2017; Martin et al., 2015; Vancouver & Kendall, 2006; Wäschle et al., 2014). Accordingly, research that seeks to identify the conditions that result in a failure to act in line with one's intentions (i.e., the conditions that lead to the occurrence of an intention-action gap; Sheeran & Webb, 2016) will need to go beyond the examination of individual differences in procrastination tendencies. Accounting for individual differences in students' procrastination behavior that can be attributed to trait-based determinants, the primary purpose of the present dissertation was to determine intra-individual mechanisms that affect the actual occurrence of procrastination behavior in real-life academic situations. To capture momentary changes (i.e., within-person changes) in motivational and volitional determinants that precede the occurrence of procrastination behavior, an event-based experience sampling approach was developed and implemented in a total of three studies.

Study 1 (Chapter 2) set out to examine whether the occurrence of behavioral delays (the occurrence of an intention-action gap) would be predicted by within-person changes in students' cognitive-affective appraisals of tasks that arise between successive stages of goal-directed action. For one week, *N* = 75 students used an electronic diary (e-diary) to indicate their intentions to work on academic tasks (582 tasks planned) and their task-related appraisals

(*expectation* to realize their intention, task *value*, and task *aversiveness*, and the *effort* required) each evening. For each intended task, a second assessment requested the next day determined whether students' task-related appraisals changed, and whether they realized their intention on time or delayed working on the task (21.2% delays based on 501 completed task-specific measurements). Stepwise two-level logistic regression analyses revealed that lower expectations of success (i.e., ratings falling below an individual's average) predicted an increased probability for task-specific delays. The risk that a task was delayed increased significantly when within-person changes in students' appraisals indicated a devaluation (i.e., decreases in task-value, and increases in task-aversiveness). Students' general procrastination tendencies that have been assessed at baseline have not significantly contributed to explain their individual delay behavior.

To more accurately determine whether the occurrence of a behavioral delay should to be interpreted as procrastination behavior, a new 5-item short scale (the ecological Momentary Assessment of Procrastination Scale, e-MAPS) was developed and tested for its psychometric properties in Study 2 (Chapter 3). The applicability of the e-MAPS was tested in an experience sampling study with *N* = 80 students who were instructed to schedule at least two tasks they intended to work on for each of 17 days. At the time they intended to realize their intentions (2651 tasks planned), students were asked whether they worked on their task, or delayed working contrary to their original intention. If they had delayed working on their task (231 delays reported by 65 participants), participants were asked to complete the e-MAPS. An exploratory factor analysis revealed that the e-MAPS items covered two latent components, supporting the preconception that both situational and cognitive-affective determinants were relevant to classify a delay as procrastination behavior (25.5% of the delays classified as procrastination). A confirmatory factor analysis indicated that individual differences in delay patterns were assessed reliably. Associations between individuals' aggregate frequencies of procrastination behavior captured by the e-MAPS, and their procrastination tendencies captured at baseline using two established self-report scales, support the convergent validity of the new scale.

Study 3 (Chapter 4) extended the findings presented in Study 1 using the e-MAPS to examine the influence that students' perceptions of task-related ambiguity (i.e., uncertainty about actions or means required to successfully

accomplish a task) had on the occurrence of procrastination behavior in studying for an exam. Questionnaires assessing students' (*N* = 88) procrastination tendency and conscientiousness at baseline were combined with an adaptive experience sampling approach to assess students' task-related perceptions of ambiguity and their situation-specific procrastination behavior during exam preparation six times a day for seven days (3581 measurements completed). Results revealed that 30% of 2286 intended study sessions were procrastinated. Study sessions were significantly more likely to be procrastinated when the momentary task-related ambiguity perception exceeded an individual's average ambiguity perception (i.e., averaged across all intended study sessions). Students with pronounced procrastination tendencies were more likely, while more conscientious students were less likely to procrastinate study sessions. However, students' conscientiousness explained virtually no variance in their procrastination behavior that was not explained by their general procrastination tendency. There was no indication for individual differences in the effect of ambiguity perceptions on the risk for procrastinating study sessions that could have been explained by students' general procrastination tendency or conscientiousness.

Two main conclusions can be drawn from the studies presented: First, it seems pertinent to consider trait-based determinants and more task- or context-specific fluctuations in students' self-regulatory capacities as complementary in their influence on the occurrence of procrastination behavior. Second, our findings highlight the ongoing imperative to examine procrastination behavior not only in terms of a general trait-based behavioral tendency, but also as a behavior that unfolds over time. Moreover, the latter requires to account for the fact that not every delay of an intended action should be considered an instance of procrastination. The use of trait- and state-based measurement approaches represents a major strength of the studies included in this dissertation. The implementation of an innovative experience sampling approach provided insights into the temporal instability of students' intentions to initiate task-related actions, thus extending the available knowledge about intra-individual mechanisms that contribute to the occurrence of procrastination behavior. Further implications for research and practice will be discussed (see, Chapter 5).

Zusammenfassung

Prokrastination wird typischerweise als ein irrationales Verhalten definiert, das dadurch gekennzeichnet ist, dass die Bearbeitung wichtiger Aufgaben entgegen der ursprünglichen Absicht unnötig aufgeschoben wird, obwohl man weiß, dass dieses Verhalten zum eigenen Nachteil sein könnte (vgl. Klingsieck, 2013; Simpson & Pychyl, 2009; Steel, 2007). Nimmt man eine Trait-basierte Perspektive ein, haben Untersuchungen immer wieder gezeigt, dass die selbstberichtete Prokrastinationsneigung von Studierenden eng mit individuellen Unterschieden in Gewissenhaftigkeit, Neurotizismus oder Impulsivität in Zusammenhang steht (Ferrari & Emmons, 1995; Lee et al., 2006; Schouwenburg & Lay, 1995; Watson, 2001). Gleichzeitig kann Prokrastination als ein aufgabenspezifisches Vermeidungsverhalten verstanden werden, das aus einem Versagen der Selbstregulation resultiert (DeWitte & Lens, 2000; Howell et al., 2006; Steel et al., 2018). Um das Auftreten von Prokrastinationsverhalten als Versagen der Selbstregulation zu verstehen, sollte jedoch berücksichtigt werden, dass die selbstregulatorischen Fähigkeiten von Individuen — insbesondere ihre motivationalen und volitionalen Determinanten — im Zeitverlauf in Abhängigkeit von aufgaben- oder kontextspezifischen Einflüssen variieren können (siehe Dietrich et al., 2017; Martin et al., 2015; Vancouver & Kendall, 2006; Wäschle et al., 2014). Untersuchungen die darauf ausgerichtet sind Bedingungen zu identifizieren, die dazu führen, dass man nicht intentionsgemäß handelt (d.h. Bedingungen, die mit dem Auftreten einer Intention-Action-Gap einhergehen; Sheeran & Webb, 2016), sollten daher über die Untersuchung individueller Unterschiede in der Prokrastinationsneigung hinausgehen. Unter Berücksichtigung individueller Unterschiede im Prokrastinationsverhalten, die auf Trait-basierte Determinanten zurückgeführt werden können, war das primäre Ziel der vorliegenden Arbeit, intra-individuelle Mechanismen zu bestimmen, die das tatsächliche Auftreten von Prokrastinationsverhalten in realen Situationen des studentischen Arbeitsalltags beeinflussen. Um momentane Veränderungen (d.h. intra-individuelle Veränderungen) der motivationalen und volitionalen Determinanten zu erfassen, die dem Auftreten von Prokrastinationsverhalten vorausgehen, wurde ein ereignisbasierter Experience Sampling Ansatz entwickelt und in insgesamt drei Studien implementiert.

In Studie 1 (Kapitel 2) ist untersucht worden, ob das Auftreten von Verhaltensverzögerungen (das Auftreten einer Intention-Action-Gap) durch intra-individuelle Veränderungen in der kognitiv-affektiven Bewertung von Aufgaben, die zwischen aufeinanderfolgenden Phasen zielgerichteten Handelns entstehen, vorhergesagt werden kann. Eine Woche lang nutzten *N* = 75 Studierende ein elektronisches Tagebuch (e-diary), um jeden Abend ihre Intentionen zur Bearbeitung akademischer Aufgaben (582 geplante Aufgaben) und ihre aufgabenbezogenen Bewertungen (d.h., die *Erwartung*, ihre Intention realisieren zu können, den subjektiven *Wert* der Aufgabe, die *Abneigung* gegen die Aufgabe und die erforderliche *Anstrengung*) anzugeben. Zu jeder geplanten Aufgabe erfolgte am nächsten Tag eine zweite Befragung, um festzustellen, ob sich die aufgabenbezogene Bewertung der Studierenden änderte und ob sie ihre Absicht rechtzeitig umsetzten oder die Bearbeitung der Aufgabe verzögerten (21.2% Verzögerungen, auf Basis 501 vollständiger aufgabenbezogener Messungen). Die Ergebnisse der schrittweisen logistischen Zwei-Ebenen-Regressionsanalysen zeigen, dass geringere Erfolgserwartungen (d.h. Bewertungen, die unter dem individuellen Durchschnitt lagen) mit einer erhöhten Wahrscheinlichkeit für das Auftreten aufgabenspezifischer Verzögerungen einhergingen. Das Risiko, dass eine Aufgabe aufgeschoben wurde, erhöhte sich signifikant, wenn intra-individuelle Veränderungen in den subjektiven Bewertungen auf eine Abwertung der Aufgabe hindeuteten (d.h. eine Verringerung des Aufgabenwertes bzw. eine Zunahme der Abneigung gegen die Aufgabe). Die allgemeine Prokrastinationsneigung der Studierenden, die zu Beginn der Studie erhoben wurde, trug nicht signifikant zur Erklärung ihres individuellen Verzögerungsverhaltens bei.

Um genauer zu bestimmen, ob das Auftreten einer Verhaltensverzögerung als Prokrastinationsverhalten zu interpretieren ist, wurde eine neue 5-Item-Kurzskala (ecological Momentary Assessment of Procrastination Scale; e-MAPS) entwickelt und in Studie 2 (Kapitel 3) auf ihre psychometrischen Eigenschaften hin untersucht. Die Anwendbarkeit der e-MAPS wurde in einer Experience Sampling Studie mit *N* = 80 Studierenden getestet, die gebeten wurden, für jeden von 17 Tagen mindestens zwei Aufgaben zu planen, die sie zu bearbeiten beabsichtigten. Zum Zeitpunkt der beabsichtigten Bearbeitung einer Aufgabe (2651 geplante Aufgaben), wurden die Studierenden gefragt, ob sie an ihrer Aufgabe arbeiteten oder die Bearbeitung entgegen ihrer ursprünglichen Absicht

aufschoben. Wenn die Bearbeitung aufgeschoben wurde (231 Verzögerungen berichtet von 65 Teilnehmern), wurden die Teilnehmenden gebeten, die e-MAPS auszufüllen. Eine explorative Faktorenanalyse ergab, dass die e-MAPS Items auf zwei latente Faktoren luden. Dies unterstützte die Annahme, dass sowohl situative als auch kognitiv-affektive Determinanten relevant waren, um eine Verhaltensverzögerung als Prokrastinationsverhalten zu klassifizieren (25.5% der Verzögerungen wurden als Prokrastination klassifiziert). Auf Basis einer konfirmatorischen Faktorenanalyse ließ sich zeigen, dass individuelle Unterschiede im Verzögerungsverhalten der Studierenden reliabel erfasst wurden. Assoziationen zwischen den aggregierten Häufigkeiten des individuellen Prokrastinationsverhaltens das durch die e-MAPS erfasst wurde, und den Prokrastinationstendenzen die zu Beginn der Studie mit zwei etablierten Selbstberichtsskalen erfasst wurden, sprechen für die konvergente Validität der neuen Skala.

Die in Studie 1 gewonnenen Erkenntnisse wurden in Studie 3 (Kapitel 4) erweitert, indem mit Hilfe der e-MAPS untersucht wurde, welchen Einfluss die Wahrnehmung von aufgabenbezogener Ambiguität (d.h. die Wahrnehmung von Mehrdeutigkeit und die damit einhergehende Unsicherheit bezüglich der Handlungen oder Mittel, die zur erfolgreichen Bewältigung einer Aufgabe erforderlich sind) auf das Auftreten von Prokrastinationsverhalten beim Lernen für eine Prüfung hat. Fragebögen, über welche die Prokrastinationstendenz und die Gewissenhaftigkeit der Studierenden (N = 88) zu Beginn der Studie erfasst wurden, sind mit einem adaptiven Erfahrungsstichprobenverfahren kombiniert worden, um die aufgabenbezogene Wahrnehmung von Mehrdeutigkeit und das situationsspezifische Prokrastinationsverhalten der Studierenden während der Prüfungsvorbereitung sechsmal täglich über einen Zeitraum von sieben Tagen (3581 vollständige Messungen) zu erfassen. Die Ergebnisse zeigten, dass 30% der 2286 intendierten Lerneinheiten prokrastiniert wurden. Lerneinheiten wurden signifikant häufiger prokrastiniert, wenn die momentane aufgabenbezogene Ambiguitätswahrnehmung die durchschnittliche Ambiguitätswahrnehmung eines Individuums (d.h. den Mittelwert über alle beabsichtigten Lerneinheiten) überstieg. Ausgeprägte Prokrastinationstendenzen gingen mit einem individuell höheren Prokrastinationsrisiko beim Lernen einher, während gewissenhaftere Studierende seltener prokrastinierten. Allerdings erklärte die Gewissenhaftigkeit der Studierenden kaum Varianz in ihrem Prokrastinationsverhalten, die nicht

auch durch ihre Prokrastinationsneigung erklärt wurde. Es ergaben sich keine Hinweise auf individuelle Unterschiede im Effekt der Ambiguitätswahrnehmung auf das Risiko, Lerneinheiten zu prokrastinieren, die durch die allgemeine Prokrastinationsneigung oder Gewissenhaftigkeit der Studierenden hätten erklärt werden können.

Aus den präsentierten Studien können zwei zentrale Schlussfolgerungen gezogen werden: Erstens scheint es angebracht, eigenschaftsbasierte Determinanten und eher aufgaben- oder kontextspezifische Veränderungen in der Selbstregulationskapazität von Studierenden in ihrem Beitrag zum Auftreten von Prokrastinationsverhalten als komplementär zu betrachten. Zweitens unterstreichen unsere Befunde die bestehende Notwendigkeit, Prokrastinationsverhalten nicht nur im Sinne einer allgemeinen eigenschaftsbasierten Verhaltenstendenz zu untersuchen, sondern auch als ein Verhalten, das sich über die Zeit entwickelt. Letzteres erfordert auch zu berücksichtigen, dass nicht jede Verzögerung einer beabsichtigten Handlung als ein Fall von Prokrastination gewertet werden sollte. Die Verwendung Trait- und State-basierter Messverfahren stellt eine wesentliche Stärke der in dieser Dissertation enthaltenen Studien dar. Die Implementierung eines innovativen Experience Sampling Ansatzes lieferte Einblicke in die zeitliche Instabilität der Intentionen von Studierenden, aufgabenbezogene Handlungen zu initiieren, und erweiterte somit das zur Verfügung stehende Wissen über intra-individuelle Mechanismen, die zum Auftreten von Prokrastinationsverhalten beitragen. Weiterführende Implikationen für Forschung und Praxis werden diskutiert (siehe Kapitel 5).

Chapter 1

1. General Introduction

1.1. Procrastination: An Expanding Field of Research

Research on procrastination has expanded over the past four decades, both in terms of the number and focus of published studies. The first frequently cited papers on academic procrastination were published in the 1980s (e.g., Beswick et al., 1988; Lay, 1986; Milgram et al., 1988; Solomon & Rothblum, 1984). PsychInfo provides 624 records for peer-reviewed articles published from 1985 through 2021, including the term *procrastination* in their title and abstract, with 426 of these articles published within the past ten years (between 2011 and 2021)[1]. More than half (55%) of the 533 empirical studies published between 1985 and today were conducted in younger populations between 13 and 29 years of age. An online survey among 16413 English-speaking participants (> 16 years of age) across eight nations revealed that younger age groups reported significantly higher levels of procrastination than older age groups (Steel & Ferrari, 2013). This finding was supported by a survey among 2893 participants from six European countries (Finland, Norway, Sweden, Poland, Italy, Germany), which has demonstrated that university students procrastinate more regularly than employees (Svartdal et al., 2016). Within a representative sample of the German population (*N* = 2527), procrastination was found to be more prevalent among the youngest age group (14 to 29 years) than among respondents aged 30 to 95 years (Beutel et al., 2016). Compared to their working peers, university students and pupils aged 14 to 29 years were significantly more likely to report that procrastination was characteristic for them (Beutel et al., 2016).

Most empirical studies have examined academic procrastination within samples of (university) students. However, estimates on the proportion of students with problematic procrastination patterns vary considerably across studies. The disparity in the reported figures can be partially explained by the different approaches that have been used to measure students' procrastination behavior. The most informative findings have been provided by studies in which students were asked to rate their procrastination behavior for a series of study-related tasks (e.g., register for courses, study for exams, writing term papers). Schouwenburg (1992) has found that 20% of students (*N* = 221 respondents) enrolled in study-skills courses reported high levels of procrastination behavior for a list of 12 study-related tasks. A survey among *N* = 242 university students enrolled in introductory psychology courses revealed that at least 30%

considered their procrastination behavior was a recurrent and severe problem in accomplishing study-related tasks such as studying for exams or writing term papers (Day et al., 2000). Likewise, Solomon and Rothblum (1984) have found that many undergraduate students (*N* = 342 participants) reported that they procrastinate very often or almost always when writing term papers (45%), studying for exams (28%), or completing reading assignments (30%). In an experience-sampling study, *N* = 45 students have indicated in 36% of all cases (1485 queries answered) that they were currently procrastinating and that their current activity (sleeping, watching television, socializing were frequently indicated) was the preferred alternative (Pychyl et al., 2000).

In contrast, the vast majority of studies have relied on questionnaires to capture students' general procrastination tendency in terms of a typical behavior pattern (or trait) that reflects the extent to which the individual chronically or habitually procrastinates working on academic tasks (cf. Schouwenburg, 2004). Referring to the distribution of scores obtained by *N* = 2088 respondents on the General Procrastination Scale (GPS; Lay, 1986), Schouwenburg (2004) concluded that students' procrastination tendencies could be considered approximately normally distributed[2], and that "almost everybody procrastinates to some extent […]" (p. 11). However, those students who reported more pronounced procrastination tendencies have been frequently shown to perform worse academically (for reviews, see: Kim & Seo, 2015; Richardson et al., 2012; Steel, 2007). It has also been reported that these students are more likely to engage in academic misconduct (Patrzek et al., 2015). In addition, it has been widely documented that individuals with more pronounced procrastination tendencies experience more stress (over time) and report lower levels of psychological and physical well-being (e.g., Beswick et al., 1988; Beutel et al., 2016; Flett et al., 1995; Rice et al., 2012; Rothblum et al., 1986; Sirois et al., 2003; Tice & Baumeister, 1997). Consequently, there is strong evidence to suggest that it is associated with negative consequences when students frequently procrastinate working on their academic tasks.

While most scholars agree that procrastination by definition should be associated with negative consequences for the individual, there is also some controversy about this criterion (Chowdhury & Pychyl, 2018; Corkin et al., 2011). Likewise, the different approaches developed to study procrastination have rarely been brought together, although they would complement rather than

contradict each other. The research approach that has been adopted in the three empirical studies presented in this dissertation has been largely informed by these developments, as I will discuss briefly in the following section.

1.1.1. Irrational Delay

Existing definitions have focused on slightly different criteria to describe procrastination (for a comprehensive overview, see Klingsieck, 2013). All of these definitions agree that procrastination involves the (temporal) *delay* of an important decision or an intended action directed at achieving some goal. Accordingly, research has distinguished between *decisional procrastination* and *behavioral procrastination*. Both types of procrastination have been commonly argued to involve an avoidance response. In both cases, it is assumed that procrastination serves to avoid a state that is experienced as unpleasant. Decisional procrastination refers to a situation in which a decision to be made within a certain period of time is delayed to avoid the stress associated with resolving complex or conflicting information (Ferrari, 1994; Janis & Mann, 1977; Mann, 2016; Mann et al., 1997). The second, behavioral type of procrastination involves delays in the implementation of an intended action (referred to as implemental delay by Svartdal et al., 2020). In this case, the unpleasant state that is avoided (be it the experience of stress, uncertainty, or fear of failure) refers to the action required to accomplish a task or achieve a goal (Flett et al., 1995; Schouwenburg, 2004; Simpson & Pychyl, 2009; Solomon & Rothblum, 1984). From an action-theoretical perspective (e.g., referring to the Rubicon Model of action phases; Heckhausen & Gollwitzer, 1987)[3], both types of procrastination can be assigned to different action phases. Decisional procrastination can be assigned to an early phase in the course of action (before an intention was formed); Behavioral procrastination concerns later phases in the course of action (i.e., post-decisional phases), since it requires the existence of an intention to act by definition. Behavioral procrastination has been more extensively addressed in previous research and is also the focus of the studies included in this dissertation.

It is further important to note that procrastination involves more than just the delay of an intended action (Chowdhury & Pychyl, 2018; Klingsieck, 2013; Steel, 2007). The second criterion typically used to define procrastination is that the delay must be “irrational” to the extent that the individual voluntarily

decides not to act in line with one's intention despite being aware that this might be to one's disadvantage (Klingsieck, 2013; Steel, 2007; 2010). Three important implications arise from this definition of procrastination:

(1) It is required that the individual has the opportunity to act and is not forced to delay one's action by present circumstances (Gollwitzer & Wieber, 2010; Klingsieck, 2013; Solomon & Rothblum, 1984).

(2) Subjective norms and the cognitive-affective appraisal of the delay determine whether it should be considered procrastination (Milgram & Naaman, 1996; Krause & Freund, 2014; Solomon & Rothblum, 1984; van Eerde, 2000).

(3) Procrastination needs to be distinguished from adaptive forms of delay (Chowdhury & Pychyl, 2018; Corkin et al., 2011; Svartdal et al., 2020).

External circumstances can make it necessary to delay the onset or interrupt the ongoing execution of an intended action. In these cases, the individual does not have the opportunity to realize one's original intention, and the delay that arises should not be considered procrastination (cf. Gollwitzer & Wieber, 2010). It can also be rational and adaptive to delay an action when one lacks required information or when a more urgent task intervenes that takes higher priority. These instances have been referred to as *active* (Corkin et al., 2011), *strategic* (Klingsieck, 2013), or *purposeful* (Chowdhury & Pychyl., 2018) delays. However, criticism was raised (Chowdhury & Pychyl, 2018; Corkin et al., 2011) against Chu and Choi's (2005) idea that there is an adaptive form of procrastination (the authors introduced the term "active procrastination" — see also Choi & Moran, 2009). Empirical findings show that measures used to capture "adaptive" vs. "irrational" types of procrastination were negatively correlated (Chowdhury & Pychyl, 2018; Corkin et al., 2011; Hensley, 2015).[4] In addition, a measure assessing students' active procrastination (Choi & Moran, 2009) was uncorrelated with self-reported and objective indicators of their procrastination behavior (Hensley, 2015). Considering that "active procrastination" was shown to be positively related to students' self-efficacy and conscientiousness, as well as negatively related to their self-reported stress levels (i.e., constructs that are typically related to conventional measures of procrastination in the opposite direction), Chowdhury and Pychyl (2018) concluded that a construct labeled

"active procrastination" would be fundamentally incongruent to accepted definitions of procrastination.[5]

1.1.2. Individual Differences

One way to determine when procrastination should be considered dysfunctional is to determine how frequently an individual engages in this behavior. The most widely used approaches in research on procrastination have been based on the implicit assumption that procrastination behavior should be considered dysfunctional to the extent that it occurs chronically or habitually (Schouwenburg & Lay, 1995; Schouwenburg, 2004). Accordingly, a large body of research has addressed procrastination in terms of a general trait or behavioral tendency (reviews provided by Klingsieck, 2013; Steel, 2007; van Eerde, 2003). Lay (1986) introduced the General Procrastination Scale (GPS), one of the first self-report questionnaires to measure individual differences in procrastination tendencies, or "the tendency to postpone what is necessary to achieve a goal" (p. 475). Research has primarily relied on this kind of self-report questionnaires (or trait-measures)[6] to discriminate individuals with a pronounced procrastination tendency (often referred to as "procrastinators") from those who have a lower procrastination tendency (often referred to as "non-procrastinators"). Based on his review of the literature, Steel (2007) concluded that the available research "suggests procrastination has sufficient cross-temporal and situational stability" (p. 67) to be considered a trait. However, it has also been cautiously scrutinized whether individuals characterized by a pronounced procrastination tendency — based on their responses to a conventional trait-measure — do procrastinate more frequently across time and situations than those characterized by a lower procrastination tendency (e.g., Klingsieck, 2013; Moon & Illingworth, 2005; van Eerde, 2003).

That being said, extensive research on trait-based differences in students' procrastination tendencies has established a very well-founded nomological network[7]. Research that has examined associations with various personality traits (most prominently with the five-factor model by Costa & McCrea, 1992) consistently found that procrastination was negatively related to conscientiousness but positively related to neuroticism (e.g., Ferrari & Emmons, 1995; Johnson & Bloom, 1995; Lee et al., 2006; McCown & Johnson, 1991; Schouwenburg & Lay, 1995; Watson, 2001; Tibbett & Ferrari, 2015).

Conscientiousness has been reported to account for about 25% of the variance in individuals' procrastination tendency (e.g., Lee et al., 2006; Watson, 2001). While all facets of conscientiousness have been found to be negatively related to procrastination tendencies, this relationship was most pronounced for the facet of self-discipline (Steel, 2007). It should be noted that this is also true when the conscientiousness items of the Neo-PI-R (Costa & McCrea, 1992) that are directly referring to procrastination (e.g., "Before working, I waste time" or "I'm something of a 'workaholic'") have been dropped (e.g., Schouwenburg & Lay, 1995; Watson, 2001). Positive associations with neuroticism have been consistently lower. While Watson (2001) reported that neuroticism accounts for 10% of the total variance in procrastination tendencies, Steel (2007) has indicated — based on his meta-analysis — that neuroticism is at best weakly related to individuals' procrastination tendency ($\bar{r}$ = .24). Lee and colleagues (2006) found that 24% of the variance in procrastination tendency was accounted for by an effect of neuroticism that was fully mediated by conscientiousness, while a direct negative relation between neuroticism and procrastination tendency was also shown. The most definite positive association with procrastination tendency was found for the neuroticism facet impulsivity (e.g., Johnson & Bloom, 1995; Schouwenburg & Lay, 1995; Watson, 2001).

A lack of self-discipline and increased impulsivity thus seem to be characteristic of individuals who report pronounced procrastination tendencies. Accordingly, Schouwenburg (2004) has noted that the tendency to procrastinate aligns to a cluster of other personality traits that may be best described by a lack of self-control (see also van Eerde, 2003). Self-control can be defined as the ability or capacity of an individual to overcome one's impulses and delay the gratification gained from an immediately available smaller reward in favor of attaining a larger reward later (Ainslie, 1975; Baumeister et al., 2007; Gillebaart, 2018; Mischel et al., 1989; Muraven & Baumeister, 2000)[8]. The finding that procrastination behavior involves a preference for a more pleasurable activity over the originally intended (goal-directed) action is as obvious as it is essential to understand the basic mechanisms behind such behavior.

Individual differences in the ability to self-control have been linked to a number of individual characteristics. For example, meta-analytic results revealed a moderate negative relationship between self-efficacy and procrastination tendencies (Steel, 2007; van Eerde, 2003). Additionally, students with

pronounced procrastination tendencies have been found to hold negative self-beliefs (or self-control beliefs). First, pronounced procrastination tendencies have been found to be associated with lower self-esteem (Harrington, 2005; Klassen et al., 2008; Rebetez et al., 2015; Steel, 2007; van Eerde, 2003). Second, some findings indicated that the negative relationship between self-esteem and procrastination tendency could be largely, if not entirely, explained by individual differences in students' self-efficacy beliefs (e.g., Flett et al., 1995; Klassen et al., 2008; Zhang et al., 2018), a low perceived ability to cope with academic problems (Flett et al., 1995), and low self-efficacy for self-regulation (i.e., the confidence about the ability to regulate and control one's behavior successfully to the desired outcome, cf. Klassen et al., 2008). However, the relationship between students' self-efficacy and their procrastination tendency (i.e., the potentially protective influence of high self-efficacy beliefs) was fully explained by the negative association between students' ability for self-regulation and their procrastination tendency (Strunk & Steele, 2011). Senécal and colleagues (1995) have found that self-regulatory abilities accounted for 25% of the variance in students' procrastination tendencies. These findings have been often linked to the idea that procrastination may serve as a strategy to protect one's self-esteem by avoiding the threat a failure (e.g., in an achievement situation) would have to be attributed to a lack of ability (e.g., Beck et al., 2000; Ferrari, 1991; Flett et al., 1995; Rebetez et al., 2015; Solomon & Rothblum, 1984). This is also consistent with the finding that students with pronounced procrastination tendencies have been more typically characterized by marked work- or performance-avoidance orientations (e.g., Howell & Watson, 2007; Wolters, 2003). In short, students with pronounced procrastination tendencies have been consistently shown to hold self-beliefs and attitudes that may limit their efforts for self-regulation.

1.1.3. Self-Regulatory Failure

Research that has adopted a more comprehensive perspective has argued that the occurrence of procrastination behavior results from a failure - or lack - of self-regulation (e.g., DeWitte & Lens, 2000; Steel, 2007; Steel et al., 2018; Wolters, 2003). This basic assumption cannot be sufficiently tested by relating individual differences in procrastination tendencies to a set of certain trait characteristics. It has been previously argued that the examination of trait-based

differences is insufficient to establish a comprehensive understanding of the conditions that determine the actual occurrence of procrastination behavior (e.g., Lay, 1992; van Eerde, 2003). However, research pursuing alternative approaches is still in the minority. Studies on procrastination behavior that examine self-regulatory failures would need to focus on the behavior and on the motivational, volitional, (meta-)cognitive, and affective processes involved. One explanatory approach that highlights this need is the mood-repair hypothesis proposed by Sirois & Pychyl (2013). This approach was based on the transactional stress model of Lazarus & Folkman (1984) and explains procrastination behavior as a maladaptive coping strategy that serves to avoid stressful experiences (or an unpleasant affective state)[9] that arises when task demands seem to exceed one's abilities, competencies, or available resources. Based on this premise, it becomes imperative to go beyond the study of personal characteristics and also consider influences of the situation or the person's subjective appraisal of the task at hand (see also Svartdal et al., 2020; Tice & Bratslaski, 2000; van Eerde, 2003; van Eerde & Venus, 2018).

This is not to say that individual characteristics or dispositions have no influence on individuals' ability to self-regulate their (learning-)behavior toward a desired goal. Most self-regulation theories agree that both stable individual dispositions and situational (i.e., context- and task-related) conditions can support or hamper the ability to self-regulate (Boekaerts, 1999; Efklides, 2011; Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 2002). Put simply, dispositional factors (including abilities, self-beliefs, and traits) at the person level operate in terms of a top-down process, whereas situational, task, and context-specific influences will come into play via bottom-up processes — often referred to as monitoring or metacognitive monitoring (cf. Efklides, 2011). During self-regulated learning (and goal-directed action), metacognitive processes (or subjective cost-benefit deliberations) provide the individual with subjective judgments (i.e., appraisals)[10] that are relevant for their goal-directed actions. Boekaerts (1993; 2001) describes these appraisals as the outcomes of ongoing comparison between the demands of the task or situation and the resources the individual requires or has available to meet those demands. Accounting for these subjective appraisals would be essential to gain a more comprehensive understanding of the proximate determinants of procrastination

behavior, which is characterized by the failure to engage in an intended task-related (or goal-directed) action.

Numerous appraisals can be relevant in this context, and there is not always agreement on which appraisal dimensions are of most significant importance (a comprehensive overview of appraisal theories is provided by, e.g., Ellsworth & Scherer, 2003). In the context of the present dissertation (Study 1, Chapter 2 and Study 3, Chapter 4), I have focused primarily on appraisals that have motivational relevance (cf. Ellsworth & Scherer, 2003). These appraisals should determine students' motivation and willingness to translate their (learning) intentions into goal-directed action. The expectation (or probability) that one will be able to attain the desired outcome and the subjective value attached to that outcome are known to influence the willingness of the person to invest effort and to translate an intention into action (e.g., Brehm & Self, 1989; Bandura, 1997; Dietrich et al., 2017; Eccles & Wigfield, 2002; Gollwitzer, 1990). Accordingly, the appraisal of task-value and the expectation to complete one's task as intended have been considered as predictors for the occurrence of behavioral delays in Study 1 (Chapter 2) of the present dissertation. The effort required to meet the demands of the task (also referred to as "opportunity costs" by Kurzban et al., 2013) has been considered as an additional appraisal dimension in Study 1. Closely connected to effort and expectancy is the perceived control over the situation (in terms of certainty vs. uncertainty about one's coping potential; Ellsworth & Scherer, 2003; Lazarus & Smith, 1988). Previous research has shown that a perceived lack of control and uncertainty about how to proceed was associated with perceptions of task aversiveness (Blunt & Pychyl, 2000), which was related to both students' procrastination tendency, and their actual procrastination behavior (Blunt & Pychyl, 2000; Lay, 1992; Pychyl et al., 2000). Accordingly, Study 3 (Chapter 4) has focused on perceptions of ambiguity (i.e., uncertainty) about task-related demands that arise from insufficient knowledge about methods or performance criteria and constrains the ability to direct one's behavior toward achieving the desired outcome (Pintrich, 2004; Tice & Bratslavsky, 2000; Skinner, 1996).

1.1.4. Temporal Perspectives

It has been previously demonstrated that students with pronounced procrastination tendencies fail to translate their intentions into action more

frequently than those with lower procrastination tendencies, while they do not differ in terms of the length or quantity of intended learning sessions (Steel et al., 2001; Steel et al., 2018). However, to understand procrastination as a volitional problem or a failure of self-regulation that has motivational origins will require more comprehensive insights into why the individual fails to act in line with one's intention (i.e., the conditions that lead to the occurrence of an intention-action gap; Sheeran & Webb, 2016). Research has to go beyond the examination of individual differences to consider that individuals' self-regulatory capacities — their motivational and volitional determinants — can change substantially over time depending on task- or context-specific influences (e.g., Dietrich et al., 2017; Martin et al., 2015; Vancouver & Kendall, 2006; Wäschle et al., 2014) to improve the present state of knowledge about what causes procrastination behavior to manifest in real-world academic situations.

However, the influence of temporal, task-, or context-dependent variability (i.e., within-person changes) in students' self-regulatory capacities that has been supposed to be associated with the occurrence of procrastination behavior has rarely been studied to date. Some previous studies examined relations between students' general procrastination tendencies and their actual procrastination behavior. However, the indicators of behavioral delay (i.e., delays in task submission or the difference between planned and actual learning time) that have been used were found to be weakly or at best moderately related to students' self-reported procrastination tendencies (DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001). Of note, the measures that have been used to capture students' procrastination behavior had some considerable limitations. The temporal discrepancy between the availability of a weekly online test and its actual completion (e.g., Moon & Illingworth, 2005; Steel et al., 2001) does not necessarily reflect procrastination behavior, as it is not known whether a student intended to take the test immediately (Klingsieck, 2013; Krause & Freund, 2014; see also Chapter 2 — Wieland et al., 2018). Studies that have recorded weekly or semi-weekly deviations between the time students intended to study and the time they spent studying (e.g., DeWitte & Schouwenburg, 2002; Krause & Freund, 2014) have considered that an intention must be present to qualify a deviation as procrastination. However, Krause and Freund (2014) note that this approach

ignores other essential criteria for the presence of procrastination behavior (see also Svartdal et al., 2018).[11]

Besides the weaknesses of the indicators used to capture students' procrastination behavior, the fact that the studies mentioned above have initiated efforts to examine students' behavior over time (mostly over the course of the semester) has to be appreciated. At the same time, however, their primary interest was to examine whether the temporal development of procrastination behavior would differ between students with more (vs. less) pronounced procrastination tendencies (i.e., again taking a between-person differences perspective). It has been tested whether the principle of temporal discounting (see Ainslie, 1975)[12] that has been adopted in the Temporal Motivation Theory (TMT, Steel & König, 2006) would be reflected in the temporal development of students' procrastination behavior. However, the results have been rather inconclusive (e.g., DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Moon & Illingworth, 2005).

With this in mind, we should consider the following: First, prior research on the time course of students' procrastination behavior has made little effort to relate the immediate occurrence of procrastination episodes to situation-specific variations (i.e., within-person changes) in students' self-regulatory capacities. Second, a long-term goal (e.g., submitting an assignment; or achieving the required number of interim tests) was typically set as the temporal frame of reference to interpret students' procrastination behavior. This was further reflected in the statement that "procrastinators tend to have a *larger* intention-action gap" (Steel et al., 2018, p. 10, emphasize added). No doubt, this can be a reasonable perspective, given that the negative consequences of procrastination behavior (e.g., poorer academic performance or feelings of stress) become visible primarily in the long run (e.g., Kim & Seo, 2015; Sirois et al., 2003; Tice & Baumeister, 1997). However, it would be equally important to investigate the mechanisms behind the occurrence of behavioral delays in intensive longitudinal studies on students' procrastination behavior.

As pointed out in the previous section on self-regulation, it seems reasonable to adopt a different temporal perspective to link a failure of self-regulation to the occurrence of procrastination behavior (or the onset of an intention-behavior gap). Why does the individual fail to translate an existing intention into action? This question may be more easily addressed if we think about the course

of action as a process, including different phases. Svartdal and colleagues (2020), referring to the Rubicon Model of action phases, note that there are three types of procrastination (1) decision procrastination in the transition between deliberation and decision, (2) the delayed onset of action implementation once the intention has been formed, and (3) sustained procrastination that occurs over the long-term progress of goal-directed action. The latter type of procrastination has been addressed in most of the longitudinal examinations outlined above. However, according to the findings presented by Svartdal and colleagues (2020), the primary problem seems to arise in the second phase, i.e., the delayed implementation of the intended action. The studies included in this dissertation were conducted to examine precisely this second type of procrastination, that is a failure to act in line with one's intentions.[13] Therefore, the temporal frame of reference for the observation of the delay is the intention of the individual (i.e., the "subjective norm" referred to in the previous section on Irrational Delay).

Cross-sectional analyses of between-person differences generally constrain opportunities to uncover within-person variability in students' (learning) behavior arising from task- or context-specific influences and/or relevant (e.g., self-regulatory) intra-individual processes (cf. Molenaar, 2004; van Eerde, 2003; Schmitz, 2006; Voelkle et al., 2014). In the three studies presented in this dissertation, classical measures of between-person differences in procrastination tendencies were combined with an adaptive experience sampling approach. The Experience Sampling Method (ESM, Csikszentmihalyi & Larson, 1987; Hektner et al., 2007) is an Ecological Momenty Assessment (EMA) method used to assess the behavior and/or experience of individuals in real-time (or close to it), through multiple measurements within their natural environment (cf. Trull & Ebner-Priemer, 2013). This method facilitates the detection of moment-to-moment changes in the experience and behavior of the individual and is typically implemented using electronic diaries (e-diaries) on mobile phones (Bolger et al., 2003; Ebner-Priemer & Trull, 2011). Therefore, we have taken advantage of this state-of-the-art approach to examine procrastination behavior in students' everyday lives in the three studies that will be presented in the following.

1.2. The Present Dissertation: Research Goals and Outline

To obtain a more complete picture of the conditions that increase students' risk to delay working on their academic task, research focusing on between-person differences in procrastination tendencies needs to be extended to include momentary, task- and situation-specific variability in behavioral determinants that occur within the individual over time. The purpose of the present dissertation was to investigate intra-individual mechanisms that affect the actual occurrence of procrastination behavior in real-life academic situations while accounting for individual differences in procrastination patterns that can be attributed to trait-based determinants. An event-based experience sampling approach was developed and implemented in a total of three studies to capture situational, task-related, moment-to-moment variability (i.e., intra-individual changes) in motivational and volitional determinants that coincide with the occurrence of procrastination behavior.

Procrastination behavior manifests in an *intention-behavior gap* (Sheeran, 2002; Sheeran & Webb, 2016), which is thought to arise from a lack of self-regulatory capacity (Steel, 2007). Accordingly, the event-based experience sampling approach used throughout the present studies has been designed to capture events of a failure to implement goal-directed action intentions (vs. their implementation). The goal toward which these action intentions were directed was the accomplishment of study-related tasks.

It was examined whether impairments in students' self-regulatory capacities, reflected by an unfavorable appraisal of the task at hand, predicted the occurrence of behavioral delays (Study 1) or procrastination behavior (Study 3), respectively. Study 2 was designed to provide an instrument that could additionally determine whether or not a behavioral delay met other necessary criteria to indicate the presence of procrastination behavior (this instrument was applied in Study 3).

In addition, a measure of students' procrastination tendency (i.e., conventional trait-measures; cf. Steel., 2010; Schouwenburg, 2004) has been used in each of the studies. The Tuckman Procrastination Scale (TPS, Tuckman, 1991; German version by Stöber, 1995) was used in Study 1 and Study 2, respectively; while the General Procrastination Scale (GPS, Lay, 1986; German version by Klingsieck & Fries, 2012) was applied in Study 3. In addition, the Academic Procrastination State Inventory (APSI, Schouwenburg, 1995; German

version by Helmke & Schrader, 2000), a measure that has been widely used in previous studies to assess students' "state procrastination" in the past week, has been applied in Study 1 and Study 2. Since conscientiousness is the personality trait most consistently found to be negatively associated with procrastination tendencies in previous studies (cf., Steel, 2007; van Eerde, 2003), this scale of the NEO-FFI (Costa & McCrea, 1992; German version by Borkenau & Ostendorf, 2008) has been additionally applied in Study 3.

Thus, in the studies presented, participating students have been asked to report (1) once about their procrastination tendencies, as well as (2) several times for at least one week during the semester (a) about their task-specific action intentions (e.g., studying for an exam, Study 3), (b) about their current (work vs.) procrastination behavior, and (c) about their task-related appraisals (Study 1 and Study 3). Accordingly, the presented data have a multilevel structure (multiple event-based measurements nested in individuals) and were analyzed using suitable procedures that account for this structure (Multilevel Structural Equation Models (MSEM): Logistic multilevel regression and factor analyses). The results shed light on (1) the effects that momentary (i.e., situation-specific) cognitive-affective appraisals of study-related tasks had on the occurrence of procrastination behavior and (2) the relative contribution of between-person differences in task appraisals and trait-based determinants.

The following chapters (Chapter 2, Chapter 3, Chapter 4) present the three studies included in this dissertation. These studies have been published in advance (Study 2, Chapter 3) or have been submitted for publication in scientific journals (Study 1, Chapter 2, and Study 3, Chapter 4). An appropriate reference precedes these chapters[14]. Note that the studies presented in the following can be read and understood independently of each other.

Study 1 (Chapter 2) aimed to examine whether the occurrence of behavioral delay was associated with short-term (momentary) changes in task appraisals that occurred between phases of the action process (i.e., after intention formation). Within a sample of *N* = 75 university students, we used an event-based experience sampling approach to assess students' task-specific appraisals twice for each intended task (when a task was planned and when the task-specific action was to be realized) and to capture the occurrence of task-specific delays throughout one week. The multilevel logistic regression analyses revealed that initial self-reported trait-like procrastination tendencies (i.e., individual

differences captured at baseline via the TPS and the APSI) did not predict differences in the actual self-reported occurrence of delays. However, unfavorable momentary changes in the individual's task-specific appraisals were significant predictors of task-specific delays. A likely explanation for the fact that trait measures did not predict the behavioral outcome measure is that the observation of a delay does not necessarily equate to procrastination.

Therefore, a measure was needed to determine if a delay was procrastination. For this reason, a new self-report measure was developed in **Study 2** (Chapter 3) that was designed to be used in an experience sampling study. The short-scale developed (*ecological Momentary Assessment of Procrastination Scale*, e-MAPS) provides a tool to capture the manifestation of procrastination in everyday life and thus to examine the dynamic, time- and context-dependent processes involved in the occurrence of procrastination behavior. The five-item short scale was used in an experience sampling study with *N* = 80 students using an e-diary for 17 days during the ongoing term. Chapter 3 provides insight into the development of the e-MAPS and presents the results of the analysis of its psychometric properties (based on Exploratory- and Confirmatory Factor Analyses). The results indicate that individual differences in the patterns of procrastination behavior were captured reliably. The associations between students' self-reported procrastination tendencies, captured via the TPS and the APSI at baseline, and self-reported procrastination behavior (captured via the e-MAPS) provide support for the convergent validity of the new scale (in the meantime, additional results are available from other studies and will be addressed in other parts of this dissertation).

In **Study 3** (Chapter 4), the e-MAPS has been applied in an experience sampling study (*N* = 80 students) to examine the influence of students' appraisals of task-related ambiguity (i.e., uncertainty) on the occurrence of procrastination behavior over one week during the exam preparation period. The logistic multilevel regression analyses revealed that appraisals of ambiguity predicted events of procrastination behavior and that students' procrastination tendency captured at baseline (using the GPS) predicted between-person differences in their procrastination behavior. Conscientiousness (recorded using the Neo-FFI) predicted between-person differences in procrastination behavior, but this effect did not hold when the influence of procrastination tendencies was

controlled (due to shared variance). Implications for the instruction and the design of study-related tasks are discussed.

Chapter 5 provides a general discussion of the main findings of the studies presented and discusses implications for future research. Finally, considerations are presented on how the approaches developed in the present dissertation can be applied in other fields of application.

1.3. Footnotes

[1] Of course, the total number of publications on "procrastination" during the indicated time frame well exceeds the results that can be reported based on the PsychInfo search presented. Just for the record, Google Scholar returns 3.131 results with "procrastination" in the title for the period between 1985 and 2021, to include all publications, regardless of their nature (peer-reviewed journal, book, etc.). It was not my intention to conduct an exhaustive review of the available literature. Nevertheless, these PsychInfo results give a reliable impression of the trend in number of publications.

[2] A similar conclusion can be drawn from the data presented by Klein and colleagues (2019, p. 638) for the German short form of the General Procrastination Scale (GPS-K, Klingsieck & Fries, 2012) within the younger age group of the sample that has been previously analyzed by Beutel and colleagues (2016).

[3] I refer to the Rubicon Model of action phases by Heckhausen and Gollwitzer (1987), as it is one of the most widely known models to describe different phases in the course of goal-directed action (the phase of goal setting and intention formation; of planning; of action implementation; and termination). However, other models would be equally useful to describe these phases (for example: Zimmerman's cyclical model of self-regulation, 2002; or the Goal Phase System described by Steel and Weinhardt, 2018).

[4] A third type of procrastination was suggested by Ferrari (1992). He introduced the term "arousal procrastination" to describe behavioral delays that serve the "purpose" to increase motivation by increasing the individual's excitement level creating time pressure. However, this construct has been challenged on theoretical and empirical grounds (e.g., Simpson and Pychyl, 2009; Steel, 2010). Contrary to the argument that procrastination is "irrational" by definition, the concept of "arousal procrastination" claims that the behavioral delay was purposefully planned.

[5] I have adopted the more widely accepted perspective and refer to behavioral delays that can be considered dysfunctional when using the term "procrastination" in the context of the present dissertation.

[6] The General Procrastination Scale (GPS; Lay, 1986) has been applied in Study 3 (Chapter 4); The Tuckman Procrastination Scale (TPS; Tuckman, 1991) has been applied in Study 1 (Chapter 2), and in Study 2 (Chapter 3). The Academic Procrastination State Inventory (APSI, Schouwenburg, 1995) has been used as a "state-measure" of procrastination in Study 1 and in Study 2. The APSI assesses the self-reported frequency of procrastination over the past week, primarily focusing on distractions while working on study-related tasks (cf. Svartdal et al., 2020). The interested reader is kindly referred to Ferrari, Johnson, & McCown (1995, chapter 3), Steel (2010), or Svartdal and Steel (2017) for comprehensive overviews on available self-report questionnaires (i.e., trait-measures).

[7] The "nomological network" has been established by Cronbach and Meehl (1955) in their discussion on construct validity: A construct is implicitly defined by its position in a network of other constructs. The nomological network is derived from theory and must follow scientific (statistic or deterministic) laws that relate observable properties or quantities to each other;

or relate theoretical constructs to observables; or relate different theoretical constructs to each other (cf. Cronbach & Meehl, 1955, p. 290).

[8] I am well aware about the differing conceptions on self-control expressed in the cited references. However, the definition that I present at this point is in accordance with the different conceptions expressed in the literature. I do not get into detail about the discussion on whether self-control is "more than the effortful inhibition of impulses" (cf. Fujita, 2011; see also De Ridder et al., 2012; Gillebaart & De Ridder, 2015). What I suggest here (in line with Gillebaart, 2018) is that self-control is part of the broader concept of self-regulation. Self-control requires self-monitoring and self-monitoring is a self-regulatory operation (see also Gillebaart, 2018). I will therefore not use these terms "self-control" and "self-regulation" synonymously throughout the following.

[9] Sirois and Pychyl (2013) use the term "emotion" or "mood" in this context. However, the experience could be equally described as an affective experience, the experience of stress, an emotional state (for an excellent discussion on what is an emotion, the interested reader is kindly referred to Gross, 2015). For the present context, it will not be of relevance to specify the exact nature of the unpleasant state experienced. What should be noted is that there is evidence to suggest that individuals with more adaptive emotion regulation competencies (especially tolerance for negative emotions) do typically report a lower procrastination tendency (e.g., Eckert et al., 2016; Harrington, 2005; McCown et al., 2012; Rebetez et al., 2015). However, the focus of the present dissertation is not primarily on understanding the emotional processes associated with the occurrence of procrastination behavior. Instead, the question addressed concerns the actual influence that an individual's cognitive-affective evaluation (or appraisal) of the task may have on the occurrence of procrastination behavior. I will not discuss emotional processes of self-regulation in more detail at this point.

[10] Appraisals are momentary judgments about a situation, an event, or a specific task. The term appraisal derived from Lazarus and Folkman's (1984) transactional stress theory, while Boekaerts (1999) applied the concept specifically to the learning situation. Notably, appraisals are not equivalent to attributions, a term introduced by Weiner (1986) that refers to judgments about the outcomes of one's task-related performance. Both appraisals and attributions influence motivation, but appraisals precede or accompany the performance of task-related actions, whereas attributions are concerned with the performance outcome (cf. Crombach et al., 2003). Attributions are not addressed in the present dissertation.

[11] Chapter 3 provides a more detailed discussion on the criteria necessary to classify a delay as procrastination.

[12] I will not go into detail about the principles of temporal discounting. The interested reader is kindly referred to Steel & König (2006), or Steel & Weinhard (2018), who present an excellent discussion of this principle.

[13] Please note that all studies presented in this dissertation have been planned and conducted prior to the publication of Svartdal and colleagues (2020).

[14] When this dissertation was submitted to the examination committee, Study 1 (Chapter 2) and Study 3 (Chapter 4) were already submitted for publication in scientific journals (under review). At the time this dissertation is published, both studies were either published or in press. A reference to the revised version that was published after the peer review process can be found at the beginning of the chapters.

1.4. References

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Chapter 2

2. 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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2.1. Abstract

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.

2.2. 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 (Klingsieck, 2013; Simpson & Pychyl, 2009; Steel, 2007). 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 (Richardson et al., 2012; Steel et al., 2001; Tice & Baumeister, 1997; van Eerde, 2003). In addition, increased procrastination tendencies were found to be positively related to indicators of impaired mental well-being (e.g., Beutel et al., 2016; Grunschel et al., 2013; Krause & Freund, 2014; Tice & Baumeister, 1997). 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 (Beswick et al., 1988; Day et al., 2000; Schouwenburg, 2004; Solomon & Rothblum, 1984).

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; Klingsieck, 2013; Steel, 2007; van Eerde, 2003). 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., DeWitte & Schouwenburg, 2002; Howell & Buro, 2009; Howell et al., 2006; Steel et al., 2001). Effective self-regulation would require that individuals apply regulatory strategies that allow them to adapt their cognition, motivation, and behavior to deal successfully with a given task (e.g., Boekaerts, 1999; Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 2002). 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). However, the common practice to rely on cross-

sectional designs and self-report questionnaires—assessing individual differences in students' general procrastination tendency—precludes the possibility of recognizing within-person processes or context-specific influences involved in the occurrence of delay behavior under real-life conditions (see also Molenaar, 2004; Schmitz, 2006; van Eerde, 2003).

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., Howell et al., 2006; Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001), and discontinuously declined over time towards the deadline (as proposed by Temporal Motivation Theory, Steel & König, 2006; Steel et al., 2018). However, 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 (Voelkle et al., 2014; van Eerde, 2003). Accordingly, research on potential indicators for self-regulatory failures that are thought to precede the occurrence of task-specific delay behavior under real-life conditions is scarce. The present study goes beyond the analysis of between-person differences and examines whether changes in behavioral determinants that arise in the course of action within individuals and may indicate a failure of self-regulation predict the actual occurrence of task-specific behavioral delays under real-life conditions.

2.2.1. From Between- to Within-Person Perspectives in Research on Procrastination

For the most part, previous research on procrastination has been based on the assumption that individuals possess a more or less pronounced procrastination tendency (Ferrari, 1991; Schouwenburg & Lay, 1995; Schouwenburg, 2004; van Eerde, 2003). Numerous studies have examined between-person differences in students' self-reported procrastination tendencies using procrastination scales or inventories (for reviews, see Klingsieck, 2013; Steel, 2007; van Eerde, 2003). 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 & Bloom, 1995; Schouwenburg, 2004; Steel, 2007; van Eerde, 2003; Watson, 2001).

More comprehensive explanations suggest that procrastination results from self-regulatory failure, which would imply that the individual fails to direct one's cognition, motivation, and behavior to the attainment of some long-term goal (e.g., DeWitte & Lens, 2000; Howell et al., 2006; Steel & König, 2006; Wolters, 2003). 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 (Brownlow & Reasinger, 2000; Senécal et al., 1995), hold mastery-avoidance or work-avoidance orientations (Howell & Buro, 2009; Howell & Watson, 2007; Wolters, 2003), 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 (Corkin et al., 2011; Howell & Watson, 2007; Wolters, 2003), which makes it difficult to regulate their behavior effectively.

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., Boekaerts, 1999; Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 2002). 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.

2.2.2. 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 (Austin & Vancouver, 1996; Heckhausen & Gollwitzer, 1987; 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 (Ajzen, 1991; Cooke & Sheeran, 2004; Gollwitzer, 1990; Sheeran & Abraham, 2003; Steel & 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; Bandura, 1997; Eccles & Wigfield, 2002; Locke & Latham, 2002; Gollwitzer, 1990; Steel & 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 & Self, 1989; Dietrich et al., 2017; Eccles & Wigfield, 2002; Gollwitzer, 1990; Klein et al., 1999).

Modern expectancy-value theory (e.g., Eccles, 2005; Eccles & Wigfield, 1995; Wigfield & Eccles, 2000) 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 & 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, although the value determinant has been separated into four conceptual sub-components: attainment value, intrinsic value, utility value, and costs (Eccles, 2005; Eccles & Wigfield, 2002), all but the latter have been found to be highly correlated within an academic domain or learning situation (e.g., Dietrich et al., 2017; Trautwein et al., 2012). For the present study, we focus on the attainment value sub-component, which reflects the personal importance of successful task accomplishment (e.g., Wigfield & 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., Dietrich et al., 2017; Flake et al., 2015; Trautwein et al., 2012). 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.

In summary, three primary determinants can be identified that appear to shape students' attitudes towards their academic tasks and thereby influence their initial willingness to take action: Their subjective judgments about expectations of success, the value of the task, and the effort required. However, the mere formation of a strong intention does not guarantee task accomplishment (Ajzen, 1991; Cooke & Sheeran, 2004; Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987). 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 & 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 & Sheeran, 2004).

Any Delay is the Deviation from an Intention

The model of action phases (Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987) describes a temporal sequence of different stages that have to be passed during goal-directed action. After the first motivational stage of intention formation (predecisional phase) has been completed, the 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 (Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987). Various difficulties can arise both within and in the transition between these phases, posing a challenge for self-regulation (discussed in detail by Gollwitzer & Sheeran, 2006; Wieber & Gollwitzer, 2010).

The realization of an intention will often involve prospective planning (Gollwitzer, 1990; Pintrich, 2000; Zimmerman, 2002), but the plans for translating an intention into action should still be relatively flexible (i.e., adaptable). Self-regulation theories (e.g., Boekaerts, 1999; Pintrich, 2004;

Zimmerman, 2002; Winne & Hadwin, 1998) 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 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 explicitly involve (meta-)cognitive processes that allow the individual to 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., Inzlicht et al., 2014; Pintrich, 2000; Zimmerman, 2002). 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., Boekaerts, 1999; Kuhl, 1992; Pintrich, 2004; Winne & Hadwin, 1998). 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., Dietrich et al., 2017; Martin et al., 2015; Tanaka & Murayama, 2014; Vancouver & Kendall, 2006). 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., Dietrich et al., 2017; Tanaka & Murayama, 2014; Vancouver & Kendall, 2006). Unfortunately, task-specific influences and the effects of within-person fluctuations in determinants associated with the occurrence of delay behavior have rarely been studied to date. However, there is some evidence that procrastination is particularly likely to occur for tasks that students perceived as being particularly aversive, unpleasant, difficult, boring, or effortful (Blunt & Pychyl, 2000; Ferrari & Scher, 2000; Lay, 1992; Pychyl et al., 2000). Moreover, students' experience of task aversiveness has been found to be considerably influenced by their current (e.g., affective) state (Blunt & Pychyl, 2000; Milgram et al., 1995; Pychyl et al., 2000) and thus appears to be rather situation-dependent. However, additional

research focusing on the longitudinal examination of task-specific behavioral processes would be 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.

2.2.3. 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*).

2.3. Method

2.3.1. 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 (movisensXS 0.8.4203 movisens GmbH, 2015; movisensXS 1.0.4434 movisens GmbH, 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.

2.3.2. 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 p.m. and 9:00 p.m.). 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 p.m. and 11:00 p.m. 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 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. 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).

2.3.3. 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.

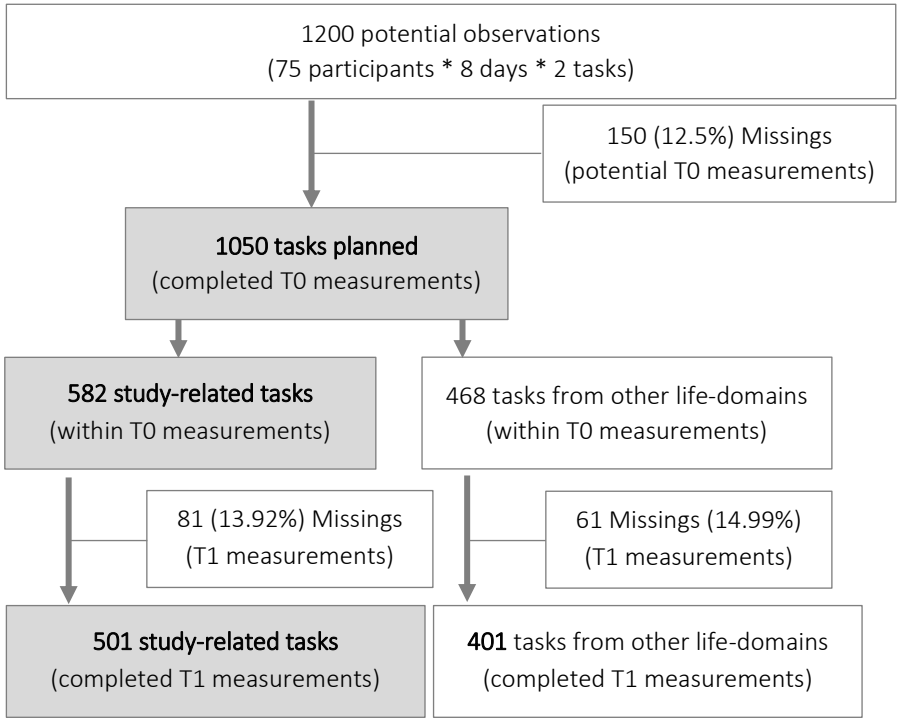

Figure 1. Data flow indicating the subset of Level 1 observations available for the analyses conducted to answer the research questions under investigation. In total, *n* = 501 Level 1 observations fulfilled the eligibility criteria (shadowed boxes): Participants (Level 2; *N* = 75) planned a task (T0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

Momentary task-specific appraisals

Single-item solutions 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., Goetz et al., 2016; Hoeppner et al., 2011; Lucas & Donnellan, 2012; Robins et al., 2001).

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).

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 begin to work on that task / reach that goal tomorrow" — (*very unlikely* to *very likely*). These items were adapted from previous studies (Kappes & Oettingen, 2014; Oettingen et al., 2015; Sevincer et al., 2014). We further assessed the anticipated *effort* required for working on a task as the third behavioral determinant (e.g., Barron & Hulleman, 2015; Eccles, 2005) 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*). Finally, participants' subjective appraisal on the pleasantness (vs. *aversiveness*) of a task was assessed 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 & 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 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 .83 within our sample.

The 12-item *state-procrastination* subscale of the German version of the Academic Procrastination State Inventory (APSI-d: Helmke & Schrader, 2000; originally developed by Schouwenburg, 1995) asks for the frequency of interruptions or distractions that occurred during learning activities *within the last 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 .79 within our sample.

2.3.4. 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 & 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 & 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[4], 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 (Muthén & Muthén, 2018; Satorra & Bentler, 2010).

2.4. Results

2.4.1. Descriptives

There was no significant difference in general procrastination tendencies (TPS, $t(72) = 0.21$, $p = .83$; APSI-p, $t(72) = 0.31$; $p = .76$) 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 $B = 2.093$ ($p < .001$). There was significant between-person variance in tasks being delayed versus worked on ($s^2 = 3.217$; $p = .001$; 95% CI = 1.368; 5.066), indicating that 49% of the relative risk to delay (vs. work on) academic tasks was explained by between-person variance in students' delay patterns (ICC = .49)[5].

2.4.2. 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 $B = 2.278$ ($p < .001$) when all predictors covering task value assessments are zero.[6] The risk that a task was delayed (vs. worked on) decreases significantly with one unit increase in the initial (T0) assessment of task value ($B = -0.866$; $p = .003$; OR = 0.41).[7] 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 ($B = -0.951$; $p < .001$; 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).

Table 1. *Descriptive Statistics (Grand Mean, Standard Deviation, Range), ICC and Level-Specific Bivariate Correlations for the Unstandardized Task-Specific Evaluations (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	.40	--	.53**	.03	.06	.11	.12*	.43***
2 Value (T1)	72.70	18.89	2.0; 100.0	.43	.88***	--	-.04	-.09	.12*	.09	.42***
3 Avers (T0)	59.19	17.50	0.0; 100.0	.37	-.19	-.19	--	.41***	.35***	.32***	-.18**
4 Avers (T1)	59.20	18.33	0.0; 100.0	.43	-.11	-.20	.98***	--	.20**	.41***	-.14*
5 Effort (T0)	66.56	18.56	7.0; 100.0	.32	.41**	.37*	.28	.30	--	.56***	-.12*
6 Effort (T1)	65.28	18.02	6.0; 100.0	.21	.35*	.22	.45**	.43**	.97***	--	-.04
7 Expect (T0)	70.36	18.74	2.0; 100.0	.30	.41*	.33*	-.58***	-.52***	.18	.09	--

Note. 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). * $p < .05$, ** $p < .01$, *** $p < .001$

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

Note. 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 (i.e., original scale divided by 10).

Results of Model 2 show that average risk that a task was delayed (vs. worked on) was B = 2.225 (p < .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 = .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 = .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 = .005).

Results of Model 3 show that the average risk that a task was delayed (vs. worked on) was B = 2.089 (p < .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 < .001) when students' prospective expectations of success were zero. As expected, the risk for a task being delayed decreases significantly when task-specific expectations of success exceed the person's mean by one unit (B = -1.013; p < .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 = .019). Results of Model 5 and Model 6 (see Table 5) show 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 < .001) when all predictors are zero.

Table 3. *Distinct Multi-Level-Models Predicting the Risk to Delay (Y = 1) Versus 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)	< .001	1.630; 2.926	-	
L1	Val_{T1-T0}	**-0.951** (0.197)	< .001	-1.338; -0.564	0.386	**0.173** (.007)
L1	$Val_{T0/pmc}$	**-0.866** (0.297)	.003	-1.447; -0.285	0.412	
L2	$Val_{T0/pm}$	-0.542 (0.333)	.103	-1.195; 0.111	-	0.051 (.441)
Model 2.						
Threshold		**2.225** (0.357)	< .001	1.525; 2.962	-	
L1	Ave_{T1-T0}	**0.749** (0.263)	.004	0.234; 1.264	2.115	0.103 (.114)
L1	$Ave_{T0/pmc}$	**0.691** (0.291)	.018	0.120; 1.261	1.995	
L2	$Ave_{T0/pm}$	**1.086** (0.386)	.005	0.329; 1.843	-	0.178 (.091)
Model 3.						
Threshold		**2.089** (0.339)	< .001	1.425; 2.753	-	
L1	Eff_{T1-T0}	0.201 (0.273)	.461	-0.334; 0.737	1.223	**0.020** (.419)
L1	$Eff_{T0/pmc}$	0.361 (0.214)	.092	-0.059; 0.781	1.435	
L2	$Eff_{T0/pm}$	0.075 (0.425)	.860	-0.757; 0.907	-	0.001 (.929)
Model 4.						
Threshold		**2.313** (0.367)	< .001	1.594; 3.032	-	
L1	$Exp_{T0/pmc}$	**-1.013** (0.248)	< .001	-1.499; -0.527	0.363	0.156 (.017)
L2	$Exp_{T0/pm}$	**-1.238** (0.526)	.019	-2.269; -0.206	-	0.154 (.210)

Note. 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).

Table 4. *Model Fit for the Six Distinct and Two Combined Logistic Multi-Level Models Predicting the Risk to Delay (Y = 1) Versus Work on a Task (Y = 0).*

Model	AIC	BIC	Chi-square difference test
Null Model	452.64	454.73	--
Model 1	421.13	426.34	TRd = 609.49 > χ^2 (3) = 11.35; p < .001
Model 2	435.57	440.79	TRd = 701.19 > χ^2 (3) = 11.35; p < .001
Model 3	455.12	460.33	TRd = 625.46 > χ^2 (3) = 11.35; p < .001
Model 4	412.54	416.71	TRd = 569.50 > χ^2 (2) = 13.82; p < .001
Model 5	445.33	448.44	TRd = 742.33 > χ^2 (1) = 6.63 ; p < .001
Model 6	446.71	449.81	TRd = 960.84 > χ^2 (1) = 6.63; p < .001
Model 7	400.11	413.66	TRd = 735.00 > χ^2 (11) = 24.73; p < .001
Model 8	396.61	412.13	TRd = 10.74 > χ^2 (2) = 9.21; p < .001

Note. BIC n-adjusted; Chi-square difference to the null model, based on log-likelihood values and scaling correction factors, using Satorra-Bentler test statistic (Muthén & Muthén, 2018; Satorra & Bentler, 2010), Model 8 tested against Model 7. Two Level 1 and one Level 2 predictor for value (Model 1), aversiveness (Model 2), and effort required for working on a task (Model 3); One Level 1 and one Level 2 predictor for expectations of success (Model 4); Model 5 and 6 included one Level 2 predictor each (TPS; APSI-p). Model 1 through 4 combined in Model 7; Model 8 included all predictors included in Model 1 through 6.

Table 5. *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)	< .001	1.466; 2.831	
TPS	0.324 (0.311)	.299	-0.287; 0.934	0.030 (.591)
Model 6.				
Threshold	2.140 (0.346)	< .001	1.462; 2.819	
APSIp	-0.026 (0.268)	.923	-0.550; 0.499	0.000 (.962)

Note. 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).

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 < .001) and task aversiveness (B = 0.588; p = .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 < .001), whereas between-person differences have not significantly contributed to the explanation of variance (R^2 = 0.243, p =.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).

2.5. Discussion

Although it has been frequently suggested that procrastination results from the failure of self-regulatory mechanisms (e.g., DeWitte & Lens, 2000; Howell & Watson, 2007; Steel & König, 2006; Wolters, 2003), 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 are expressed by unfavorable task-

Table 6. *Combined Multi-Level-Models Predicting the Risk to Delay (Y = 1) vs. Work on a Task (Y = 0), Based on Initial 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)	< .001	1.78; 3.20	-	2.537 (0.358)	< .001
L1. Val_{T1-T0}	**-0.821** (0.212)	< .001	-1.24; -0.41	0.44	**-0.824** (0.212)	< .001
L1. Ave_{T1-T0}	**0.588** (0.254)	.021	0.09; 1.09	1.80	**0.583** (0.253)	.021
L1. Eff_{T1-T0}	-0.060 (0.259)	.817	-0.57; 0.45	0.94	-0.003 (0.259)	.990
L1. $Val_{T0/pmc}$	-0.570 (0.302)	.059	-1.16; 0.02	0.57	-0.597 (0.307)	.052
L1. $Ave_{T0/pmc}$	0.375 (0.262)	.152	-0.14; 0.89	1.45	0.307 (0.253)	.226
L1. $Eff_{T0/pmc}$	0.325 (0.214)	.128	-0.09; 0.74	1.38	0.339 (0.213)	.112
L1. $Exp_{T0/pmc}$	**-0.726** (0.271)	.007	-1.26; -0.19	0.48	**-0.685** (0.271)	.011
L2. $Val_{T0/pm}$	-0.244 (0.398)	.540	-1.02; 0.54	-	-0.491 (0.379)	.195
L2. $Ave_{T0/pm}$	0.880 (0.468)	.141	-0.23; 1.61	-	0.482 (0.453)	.288
L2. $Eff_{T0/pm}$	-0.034 (0.495)	.945	-1.00; 0.94	-	0.065 (0.484)	.892
L2. $Exp_{T0/pm}$	-0.830 (0.605)	.170	-2.02; 0.36	-	-0.902 (0.617)	.144
L2. TPS_{bl}	-	-	-	-	0.397 (.147)	.274
L2. $APSIp_{bl}$	-	-	-	-	-0.185 (.462)	.252

Note. 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.

[a] n_{L1} = 501 tasks, R_{L1}^2 = 0.299 (p < .001); N_{L2} = 75 participants, R_{L2}^2= 0.243 (p = .081).

[b] n_{L1} = 497 tasks, R_{L1}^2 = 0.290 (p < .001); N_{L2} = 74 participants, R_{L2}^2= 0.283 (p = .054).

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. Unexpectedly, between-person differences in general procrastination tendencies have not significantly contributed to the prediction of students' delay behavior patterns.

2.5.1. 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; Wäschle et al., 2014; Wolters, 2003). 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., Glick & Orsillo, 2015; Steel & König, 2006; Steel & 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 (Gollwitzer, 1993; Hollenbeck & Klein, 1987; Klein et al., 1999; Wieber & 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 & Latham, 1990; Locke et al., 1988) 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 some previous diary studies (e.g., Ferrari & Scher, 2000; 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., Lay, 1992; Milgram et al., 1995; Milgram et al., 1988). This association may seem self-evident, but it has not yet been sufficiently clarified what constitutes a task being perceived as exceptionally aversive. Blunt and Pychyl (2000) examined the meaning of students' task aversiveness perceptions across different stages of goal pursuit. Their analysis revealed that tasks that are delayed because they are perceived as aversive are frequently perceived as being frustrating or boring as well. According to Pekrun's control-value theory of achievement emotions (Pekrun, 2006; Pekrun et al., 2007), 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). However, based on the results of the present study, 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.

In contrast to previous studies, where students' preferences for avoiding effort was associated with elevated procrastination tendencies (e.g., Ferrari & Scher, 2000; Wolters, 2003; Howell & 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; Inzlicht & Schmeichel, 2012; Muraven & Baumeister, 2000). 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 do 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 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.

2.5.2. 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 (meta-) cognitive 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 & Schouwenburg, 2002; Steel et al., 2018; Steel & König, 2006).

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., Corkin et al., 2011; Howell, & Watson, 2007; Klassen et al., 2008; Wolters, 2003). However, self-regulated learning is conceptualized as an intra-individual, task- and context-specific process (e.g., Inzlicht et al., 2014; Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 2002). 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 & König, 2006; Steel & 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 (Ainslie, 2012; Steel & König, 2006), 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. Accordingly, it is less surprising that our results differ from those of a previous diary study (Pychyl et al., 2000) in which students perceived the tasks they delayed as more important (or valuable) than the alternative activities they were instead engaging in. Nevertheless, the present study has demonstrated that intra-individual devaluation processes are involved when students delay the accomplishment of their tasks, contrary to their intention.

2.5.3. 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., Blunt & Pychyl, 2000; Ferrari & Scher, 2000; Lay, 1992; 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., Wäschle et al., 2014; Wolters, 2003). 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., Boekerts, 1999; Pintrich, 2004; Zimmerman, 2002; Winne & Hadwin, 1998), 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. This finding was somewhat unexpected. In previous studies (e.g., DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001), 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 versus 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 in support of research suggesting that a merely trait-based explanation may not adequately describe the complex mechanisms involved in the occurrence of procrastination behavior (e.g., Moon & Illingworth, 2005; Steel et al., 2001). However, 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 are more or less suitable for predicting students' actual delay behavior. Therefore, we have 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.

2.5.4. 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 not to say that individuals cannot differ in their general ability to self-regulate their (learning) behavior. 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 impulsive students who are less skilled in self-regulation, which may undoubtedly affect academic achievements over a longer time scale. Nonetheless, we suggest that future studies should extend their efforts beyond the consideration of between-person differences and 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 & 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., Wäschle et al., 2014; Wolters, 2003). Wäschle and colleagues (2014) demonstrated 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. Wäschle et al., 2014 & Wolters, 2003).

It remains to be 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.

2.5.5. 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. Students reported fewer events of delay than could have been expected based on the results of previous studies (e.g., Day et al., 2000; Ferrari & Scher, 2000; Pychyl et al., 2000). It is possible that using the e-diary to evaluate their tasks and report their behavior regularly resulted in

increased self-reflection (e.g., Barta et al., 2012; Conner & Reid, 2012). However, we tried to minimize potential biases due to social desirability effects by not explicitly asking students about their "procrastination" in the e-diary. Moreover, 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 in our sampling. Some students may have been selective in the choice of the task-specific intentions indicated. 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. Also, students participating in the present study were enrolled in cross-curricular courses advertised to help students self-organize their learning. It would be desirable to replicate the results of our study in a more representative student sample. However, a comparison of our sample's average scores with other (representative) student samples (e.g., Helmke & Schrader, 2000; Stöber, 1995) showed that these were comparable in their average procrastination tendencies.

Third, 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., 2012) influence students' decisions to learn (or work on their tasks) as intended or delay learning by engaging in alternative activities.

2.5.6. 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, which will 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, research must further contribute to our understanding of the (within-person) mechanisms that invoke self-regulated learning to fail and ultimately provoke students to delay working on their study-related tasks.

2.6. Footnotes

[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.

[4] 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.

[5] The Intraclass Correlation Coeffientient (ICC) for a binary dependent variable can be computed using the formula ICC = σ_u^2 / σ_u^2 + (π^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 π^2 / 3 (cf. Schoeneberger, 2016; Sommet & Morselli, 2017).

[6] 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.

[7] 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.

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Chapter 3

3. The Ecological Momentary Assessment of Procrastination in Daily Life: Psychometric Properties of a Five-Item Short Scale

This chapter contains an adapted author copy of the published article:

Wieland, L. M., Grunschel, C., Limberger, M. F., Schlotz, W., Ferrari, J. R., & Ebner-Priemer, U. W. (2018). The ecological momentary assessment of procrastination in daily life: Psychometric properties of a five-item short scale. *North American Journal of Psychology, 20* (2), 315–339.

Note: The following chapter contains minor editorial adjustments compared to the original publication. There were two typos in the original publication, which I have revised in the version presented in this dissertation:

In the study design (p. 322 in the original publication), it has been mistakenly indicated that participants responded to the e-diary for eight days. As described in the Results section (p. 325 in the original publication), participants were requested to respond to the e-diary for a total period of 17 days. Accordingly, analyses were based on a 17-day experience sample (revision appears on p. 86 in the present chapter).

On p. 325 in the original publication, we have mistakenly referred to Table 1, though the relevant information is presented in Table 2. Accordingly, I have adjusted the numeration of the Tables in the present chapter (pp. 89 ff.).

3.1. Abstract

Whether individuals actually engage in procrastination depends on different factors (e.g., personality, temporal and situational prerequisites). In order to assess behavioral procrastination adequately, delays that qualify as procrastination must be differentiated from other forms of delay. We therefore developed the ecological momentary assessment of procrastination scale (e-MAPS). This five-item short scale was applied in an experience sampling study with 80 participants. Exploring the factorial structure of the e-MAPS revealed that the items cover two latent components, supporting the preconception that situational determinants and cognitive-affective appraisals are equally relevant to identify delays that qualify as procrastination. Preliminary evidence showed that delay patterns were assessed reliably. Associations between established self-report scales of procrastination and aggregate frequencies of behavioral procrastination, assessed by the e-MAPS, support its convergent validity. We conclude that the e-MAPS will support research on time and context dependent processes involved in the occurrence of procrastination.

3.2. Introduction

Procrastination is a well-known phenomenon defined as "the voluntary, irrational postponement of an intended course of action despite the knowledge that this delay will come at a cost to or have negative effects on the individual" (Simpson & Pychyl, 2009, p. 906; see also Ferrari et al., 1995). International prevalence rates reveal that up to 28% of the adult general population chronically engages in procrastinatory behavior (Ferrari et al., 2007). According to estimates, 20% to 70% of university students procrastinate in study-related tasks (academic procrastination) on a regular basis (Day et al., 2000; Schouwenburg, 2004; Solomon & Rothblum, 1984). Moreover, the frequent engagement in (academic) procrastination is associated with deficiencies in academic performance, heightened stress levels, depressive symptoms, anxiety, social conflicts, and decreased overall life satisfaction or physical well-being (Beutel et al., 2016; Grunschel et al., 2013a; Klassen et al., 2008; Sirois et al., 2003; Solomon & Rothblum, 1984; Tice & Baumeister, 1997). Therefore, empirical evidence consistently shows that frequent or excessive engagement in procrastination is maladaptive (Ferrari, 2010).

3.2.1. Prone to procrastinate

Research on the causes and consequences of procrastination typically aggregated scores of self-report measures to assess participants' average tendency to engage in dilatory behavior (Ferrari et al., 1995; Steel, 2007; van Eerde, 2003). The conception that procrastination is not only connected with certain personality characteristics (Ferrari & Emmons, 1995; Johnson & Bloom, 1995; Lee et al., 2006; Tibbett & Ferrari, 2015; Watson, 2001) but can be denoted as a continuous trait-like construct in itself (Schouwenburg, 2004) has promoted the common practice of categorizing the population under investigation into procrastinators and non-procrastinators. Therefore, individuals with a strong predisposition to procrastinate should engage in procrastinatory behavior more frequently than individuals with a weak predisposition to procrastinate. More importantly, this conception implicitly predicts that some (more or less pronounced) tendency to procrastinate should be reflected in behavior irrespective of temporal, situational, or contextual circumstances (e.g., van Eerde, 2003).

3.2.2. Procrastination as behavior in context

Whether an individual actually engages in procrastination also seems to be influenced by context or task characteristics (Ferrari & Scher, 2000; Klingsieck, 2013a; Pychyl et al., 2000; Rothblum et al., 1986). First, procrastination can be domain specific in the sense that a person may procrastinate on some tasks or in specific contexts but not to the same degree in different life-domains (Klingsieck, 2013a). Second, a task might have certain properties that are negatively appraised by the individual, who avoids dealing with it as a result. This was demonstrated for tasks perceived as unpleasant, aversive, stressful, difficult or effortful (Blunt & Pychyl, 2000; Ferrari & Scher, 2000; Pychyl et al., 2000). Moreover, temporal motivation theory (TMT: Steel & König, 2006) predicts that the probability of engaging in procrastinatory behavior should decrease when the deadline for task completion approaches. Therefore, the occurrence of procrastinatory behavior should be time-dependent. Unfortunately, few studies have examined the assumption of time-dependence using longitudinal designs. Those studies testify that the behavioral manifestation of a tendency to procrastinate (observed dilatory behavior) is a time-dependent phenomenon (e.g., DeWitte & Schouwenburg, 2002; Howell et al., 2006; Moon & Illingworth, 2005; Tice & Baumeister, 1997).

3.2.3. Revising the assessment of procrastination

Empirical observations of delays in task completion or the difference between planned and actual study time have been used as behavioral measures of procrastination (e.g., Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001). In fact, these behavioral proxies were weakly or at most moderately correlated with aggregate scores of established self-report scales developed to assess participants' predisposition to procrastinate (DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001; Tice & Baumeister, 1997). Based on these findings, it is debatable whether self-report questionnaires are suitable for predicting actual engagement in procrastinatory behavior (Moon & Illingworth, 2005; Steel et al., 2001). Challenging the trait-based measurement of procrastination in this regard seems justified, but the use of behavioral measures as proxies for procrastination can be criticized as well.

It is precarious to suppose that the mere observation of dilatory behavior can be reduced to procrastination. More precisely, crucial conceptual features

relevant for considering some delay as procrastination are omitted by the assessment of such behavioral proxies (Krause & Freund, 2014). This has become even more important since Chu and Choi (2005) proposed that a deliberate delay planned for some strategic reason might have positive consequences and can be considered active procrastination. This conception was criticized based on theoretical argumentation, and it was empirically shown that purposefully planned delays are conceptually distinct from dilatory behavior considered as procrastination (Chowdhury & Pychyl, 2018; Corkin et al., 2011; Grunschel et al., 2013b). Consequently, the mere observation of dilatory behavior should not be accepted as an adequate proxy for procrastination.

However, it is important to understand the processes involved in the occurrence of procrastination (van Eerde, 2003), which will undoubtedly require the assessment of behavioral procrastination as it unfolds in daily life. Inasmuch as it is reasonable to doubt the suitability of the applied behavioral measures in this regard, we must find an objective basis for judging whether some observed delay is considered procrastination.

3.2.4. A conceptualization of procrastination

Various experts have offered definitions of what constitutes procrastination, each focusing on different pivotal characteristics (for an overview see, Klingsieck, 2013b). These experts commonly agree that procrastination is inextricably linked with an act of delay. Introducing one essential prerequisite, Lay (1986) explained that this delay must be pertinent to goal-directed behavior. This implies that at a certain point in time, the individual intended to execute a goal-directed action. Steel and colleagues (2001) further stated that procrastination "comes from failing to act upon one's intentions to work" (Steel et al., 2001 p. 97). Therefore, an individual procrastinates when there is (1) an intention to work, to complete a task or to execute some goal-directed behavior but (2) delays acting in accordance with this intention. Such a delay of an intended course of action can be reasonable and even adaptive (Ferrari, 1993; Simpson & Pychyl, 2009), but a functional form of delay (*active procrastination*; Chu & Choi, 2005) contradicts other important aspects formulated to define procrastination (Chowdhury & Pychyl, 2018; Klingsieck, 2013b).

To qualify as procrastination, (3) the delay should be *unnecessary* (Solomon & Rothblum, 1984) in the sense that, objectively, the individual has the

opportunity to act (Gollwitzer & Wieber, 2010). There is no external circumstance forcing the individual to postpone the intended action. You can think of multiple scenarios where instead of following your original intention (working on a task), you have no choice but to engage in some other activity. Either something that is of higher priority intervenes (e.g., your boss calls you with an urgent request) or circumstances (e.g., a fire alarm or blackout) prevent you from acting in line with your intention. In these cases, the delay would be rational and indeed necessary and would therefore not be considered procrastination.

It was further suggested that when procrastinating, the individual is cognitively aware of the fact that the delay is unnecessary and might entail negative consequences (Klingsieck, 2013b). In other words, a delay that is considered procrastination is (4) *irrational* to the extent that the individual can expect disadvantages (decreased time for working on the task, stress before the deadline, deterioration in performance) resulting from the delay (Klingsieck, 2013b; Lay, 1986; Simpson & Pychyl, 2009; Steel, 2007; 2010). Finally, it has been proposed that procrastinating on a task should evoke (5) the experience of *subjective discomfort* (Krause & Freund, 2014; Solomon & Rothblum, 1984). Overall, procrastination is a complex construct that comprises behavioral, cognitive, and affective components (Ferrari, 1994; Solomon & Rothblum, 1984). We must examine all of these components to identify delays that qualify as procrastination.

3.2.5. Ecological Momentary Assessment of Procrastination

Now that we have a clear conceptualization of the criteria qualifying delays as procrastination, we face the challenge to assess these patterns of behavior in daily life. Ecological momentary assessment (EMA) techniques capture the behavior and experience of individuals in real-time (or close to it), by multiple measurements within the natural environment (Trull & Ebner-Priemer, 2013). This approach facilitates the discovery of moment-to-moment changes in patterns of behavior (Bolger et al., 2003; Ebner-Priemer & Trull, 2011). This requires participants to report on events or experiences occurring in their daily lives and is typically realized by the implementation of electronic diaries on mobile phones (Bolger et al., 2003).

With regard to the assessment of procrastination in daily life, one promising and straightforward approach would be to ask respondents directly if they consider their actual behavior to be procrastination (see Pychyl et al., 2000). However, this requires participants to be able and willing to recognize their behavior as procrastination. As mentioned earlier, the conceptualization of procrastination is beyond pure delay and is far more complex than commonly assumed. Fortunately, EMA is a state-of-the-art approach particularly suitable to capture the complex nature of procrastination in daily life. In particular, EMA (a) allows for prospective assessments of behavioral intentions (b) enables real-time detection of delays in intention realization, (c) concurrently permits the evaluation of delays in terms of predefined criteria for procrastination, and (d) allows one to decide whether an observed delay qualifies as procrastination. Consequently, we can adopt an indirect approach to assess behavioral procrastination in daily life using EMA.

3.2.6. The present study

We introduce the *ecological momentary assessment of procrastination scale* (e-MAPS). This 5-item short scale was designed to discriminate between delays that qualify as procrastination and those that do not and to assess momentary behavioral procrastination on multiple occasions over longer periods of time. To examine the applicability and usefulness of our new scale, we applied the instrument in an experience sampling study within an academic setting. Based on the data assessed in this initial study, we (1) explore the factorial structure of the e-MAPS items and (2) provide information on the psychometric properties of the scale. We expected that (2.1) the e-MAPS would reliably assess the variability in delay-patterns between persons. In terms of convergent validity, it was anticipated that (2.2) the individual frequency of delays identified as procrastination by the e-MAPS would be associated with aggregate scores of established self-report measures for procrastination. Thus, the primary purpose of our study was to show that the developed instrument is suitable to assess the manifestation of procrastination in daily life, thereby providing a useful tool to study the dynamic time- and context-dependent processes involved in procrastination.

3.3. Method

3.3.1. Scale development

The e-MAPS was developed to allow for an event-based assessment of procrastination. At first, this requires the observation of delays in the execution of some previously intended goal-directed action. We therefore assessed delays in the execution of goal-directed actions at the moment of their occurrence using electronic diaries (e-diaries). To determine whether an observed delay could be considered procrastination, five items[1] covering the predefined criteria for procrastination were formulated:

1. If I'm honest, putting off this task is unnecessary.
2. I'm putting off working on the task because another important task arose that took priority.
3. Putting off this task is due to circumstances that are beyond my control.
4. It is basically irrational to put off working on this task.
5. If I think about it, putting off this task makes me feel rather uncomfortable.

As outlined in the introduction, delaying the execution of an intended goal-directed action can only be verified as procrastination if this behavior fulfills specific criteria (Klingsieck, 2013b; Steel, 2007; Gollwitzer & Wieber, 2010). The first criterion deduced from the literature was that to qualify as procrastination, the delay should be unnecessary (Solomon & Rothblum, 1984). This means that the individual had the opportunity to act because there was no external reason to postpone the intended action. The first item covers this criterion in a straightforward manner. Responding to this item in the explicated context of interpretation requires the application of objective norms for assigning whether the delay is unnecessary. Two additional items were included to control for the possibility that (to maintain a positive self-image (van Eerde, 2003) the individual rationalizes (finds justifications for) the delay with respect to the first item. Complementing the unnecessary nature of the delay, these additional items delineate external influences that could make the delay reasonable. The second item covers the possibility that another (more) important task intervened, which would indicate that the delay might represent a case of setting priorities rather

than procrastination. The third item allows for the possibility that the individual was prevented from acting in line with the original intention by some external circumstance.

The second important criterion to differentiate procrastination from other (adaptive) forms of delay is the irrationality of the behavior (Klingsieck, 2013b; Lay, 1986; Steel, 2007). The behavior is irrational because the individual decides to delay the execution of the intended behavior even though this is unnecessary and the disadvantages that might result from the delay outweigh the short-term advantages of the postponement (Klingsieck, 2013b; Steel, 2010; Steel & Ferrari, 2013). Since it can be expected that the individual is cognitively aware of the fact that the delay is irrational (Steel, 2007), item four was framed in a straightforward way.

Finally, the fifth item covers the idea that to fulfill the criteria for procrastination, the delay should be accompanied by subjective discomfort (Solomon & Rothblum, 1984). These five items clearly comprise the behavioral, cognitive, and affective components that have been cited as necessary and sufficient to decide that an observed delay is due to procrastination (Ferrari, 1994; Klingsieck, 2013b; Solomon & Rothblum, 1984).

3.3.2. Scaling and interpretation of response patterns

The five e-MAPS items have a binary response format. Each time a delay is observed, the respondent is asked to indicate whether the criteria specified by the items are true (response = “yes”) or false (response = “no”) for the actual delay. It depends on the wording of the respective item, whether responding “yes” or “no” is a positive or negative response in terms of the criteria for procrastination. A “yes” response to the first, fourth and fifth item is a positive response in terms of the criteria (coding = 1) because it indicates that the delay was *unnecessary*, *irrational*, or evokes *subjective discomfort.* To the contrary, answering “no” to these items indicates a negative response in terms of the criteria (coding = 0). The coding is reversed for the second and third item. A “no” response indicates that the delay was not justified by *situational circumstances*, and is a positive response in terms of the criteria for procrastination (coding = 1), whereas a “yes” response expresses the contrary (coding = 0).

The criteria that the delay should be unnecessary, irrational, and connected to subjective discomfort, reflect the *cognitive-affective appraisal* of the delay

(CA-component: item 1, item 4, item 5). The remaining two items assess *situational determinants* (SD-component: item 2, item 3) specifying whether the delay can or cannot be considered necessary. The responses for the CA-items and SD-items are added up separately. An observed delay fulfills our criteria for procrastination if CA > 0 and SD > 0 holds true.

A new binary variable, the procrastination indicator (P-indicator), is used to classify whether an observed delay fulfills the predefined criteria for procrastination (P-indicator = 1 for CA > 0 and SD > 0) or not (P-indicator = 0 for CA = 0 and / or SD = 0). Because the delays are nested in persons, adding up the P-indicator variable for each participant results in a variable (F-indicator) containing the individual frequency of instances in which a delay was identified as procrastination. Whereas the dichotomous P-indicator discriminates between different forms of delay (0 = no procrastination; 1 = procrastination) at the situational level, the F-indicator quantifies the observed tendency to procrastinate and therefore contains information about interindividual differences.

3.3.3. Study Design and Sampling

A study to evaluate the psychometric properties of the e-MAPS was conducted in a class of 80 undergraduate students of architecture in their fourth semester at the Karlsruhe Institute of Technology in Germany. The sample was comprised of 52 female and 25 male students between 19 and 42 years of age (M = 21.44; SD = 2.74) at the time of assessment (gender and age statements missing for three participants).

Paper-pencil self-reports for the assessment of trait and state levels of procrastination were collected once at the beginning of the semester, followed by 17 days of EMA's using e-diaries. The e-diaries were implemented using an Android based experience sampling solution (movisensXS, Version 1.0.4907; movisens GmbH, 2017) that was pre-installed on smartphones. Participants were carefully instructed in the use of the e-diary and were told to contact the first author in case of uncertainties or technical problems.

To measure procrastination using the e-MAPS, it was necessary to observe delays in the execution of intended goal-directed actions. Because delays were the events of interest for the current study, we focused on the assessment of these events in the current description.

Participants used the e-diary to plan at least two tasks (e.g., "learn for exam" or "exercise") for each day of the study period. It was not specified that these had to be academic tasks, but it was stated that academic tasks were of primary interest for our research. Each day, participants were reminded to plan at least two tasks for the next day by a fixed-time prompt (9:30 p.m.). However, it was possible to enter tasks at any time, and for any day within the study period, while the study was running. When planning a task, participants were asked to indicate the date (within the study period) and time (hour and minute) of the intended start for the execution of their goal-directed action. This participant-defined start time triggered a prompt asking the participant whether to begin working on the predefined task (e.g., "learn for exam"), or to delay this action to a later point in time. Each time a participant delayed the execution of the intended goal-directed action, a new intention had to be formed (indicating a new start time). The same task could therefore be delayed several times. When a delay was indicated, the participant was requested to answer the five e-MAPS items.

At the end of the ESM period, the participants returned the smartphones used for the assessments. Partial course credit was granted for taking part in the study, and a lottery was conducted raffling two tablets (Apple iPads) for those participants who responded to at least 80% of the e-diary prompts. The local university ethics commission approved the entire study-protocol, and participants gave informed consent before beginning the assessment.

3.3.4. Measures

Two validated and widely used self-report questionnaires were used to assess procrastination at baseline. Trait procrastination, or the predisposition to procrastinate, was assessed by the German version of the *Tuckman Procrastination Scale* (TPS-d, Stöber, 1995). The TPS (Tuckman, 1991) comprises 16 items describing behaviors or attributes indicative for trait-procrastination (e.g., "When I have a deadline, I wait till the last minute" Tuckman, 1991, p. 477). We adopted a five-point Likert response scale ranging from "this is not at all true" (coded 1) to "this is very true" (coded 5) as suggested by Stöber (1995). The n = 77 participants in our study (n = 3 did not return the questionnaire) reached an average sum-score of 47.09 (SD = 9.96, range: 26–69). Cronbach's alpha for the TPS-d was .86 within this sample.

In addition, we used the German version of the *Academic Procrastination State Inventory* (APSI-d, Helmke & Schrader, 2000) developed by Schouwenburg (1995). The APSI consists of 23 items and was designed to measure the self-reported frequency of engaging in behaviors and thoughts indicative of academic procrastination within the last week (Schouwenburg, 1995). Participants indicate how frequently they engaged in the stated behaviors on a five-point Likert scale ranging from "never" or "not" (coded 0) to "always" (coded 4). A three-factor structure was verified for the APSI(-d) (Schouwenburg, 1995; Helmke & Schrader, 2000). Although Schouwenburg (1995) found 13 items loading on one factor considered to measure academic procrastination behavior (Cronbach's α = .90), this factor covers 12 items in the German version and is considered to measure *state-procrastination* (Patzelt & Opitz, 2014). For the purpose of our study, we decided to drop the remaining two subscales *fear of failure* and *lack of study motivation* (Schouwenburg, 1995) and focus on the assessment of the 12-item *state-procrastination* subscale of the APSI-d. The APSI-d was answered by n = 77 participants (n = 3 did not return the questionnaire), providing a mean-score of 1.77 (SD = 0.51, range: 0.67 – 3.17) on the *state-procrastination scale*. Cronbach's alpha for this APSI-d-scale was .78 in our sample.

3.3.5. Analysis

In a first step, the aggregate scores for the e-MAPS were calculated. We computed the binary P-indicator as well as the F-indicator quantifying the individual frequency of instances in which a delay was procrastination. In a second step, the F-indicator of each participant was matched to the corresponding APSI-d and TPS-d self-reports. For validation purposes, Pearson correlations between these measures were computed, and Mann-Whitney tests were conducted (Kolmogorov-Smirnov test indicated that the F-indicator was not normally distributed) to test for differences in the F-indicator between participants scoring high versus low (based on median splits) in the APSI-d and TPS-d, respectively. These calculations were conducted using IBM SPSS Statistics for Windows (SPSS Version 24.0.0.1; IBM Corp., 2016).

Whereas our binary response format allows us to draw a sound distinction between events of delay qualifying as procrastination and those that do not, such scaling comes with limitations in relation to data analyses. Standard

exploratory factor analyses (EFA) requires dimensional variables. Although the number of observed delays was quite large in our study, sophisticated exploratory multilevel factor analyses (ESEM: exploratory structural equation models: Asparouhov & Muthén, 2009; Muthén, 1984) capable of handling binary items in a multilevel framework would require much larger numbers of observations and participants. To explore the e-MAPS factorial structure, we therefore conducted a single-level exploratory factor analysis (EFA), ignoring the nested structure of the data. Since binary items violate the basic assumption of a normal distribution, we used tetrachoric correlations between the five e-MAPS items. These correlations were calculated in RStudio (Version 1.0.153; RStudio, 2016) using the *polycor* package (Fox, 2016).

Table 1. Tetrachoric Correlations between the Five e-MAPS Items based on 231 Observed Delays Within n = 65 Participants.

	1	2	3	4	5
Item 1 (CA)	0.24 [0.43]				
Item 2 (SD)	.291	0.48 [0.50]			
Item 3 (SD)	.552	.276	0.41 [0.49]		
Item 4 (CA)	.724	- .180	.067	0.25 [0.44]	
Item 5 (CA)	.587	- .044	.013	.491	0.21 [0.41]

Note. For each observed delay, participants indicated whether the delay fulfills the specified criterion on a binary scale (yes, no). Means [Standard Deviations] for single items presented in the diagonal. Item 1, 4, and 5 represent cognitive-affective (CA) appraisals of a delay. CA-items are coded with 1 if answered with "yes" (positive response in terms of the criteria for procrastination). Item 2 and 3 represent situational demands (SD) for a delay to be considered procrastination. SD-items are coded with 1 if answered with "no" (positive response in terms of the criteria for procrastination).

The final matrix was imported to SPSS, where the means, standard deviations and the number of observations for each item were added (see Table 1). The EFA was conducted based on these data using unweighted least squares (ULS) as the extraction method and an oblique rotation method (Oblimin), allowing factors to be correlated (for a discussion of estimator choices, see Muthén et al., 2015).

It can be assumed that the e-MAPS might not be a strictly 'unidimensional' scale. We therefore decided to follow the recommendation to use McDonald's Omega (instead of Cronbach's Alpha (Cronbach, 1951)) as indicator of scale reliability (Revelle & Zinbarg, 2009; Zinbarg et al., 2005). We adopted the approach illustrated by Bolger and Laurenceau (2013) for computing this indicator based on multilevel confirmatory factor analysis (MCFA) in Mplus (Mplus Version 8 Demo; Muthén & Muthén, 1998–2017). With categorical outcomes, the within-level variance parameter cannot be freely estimated (Raykov et al., 2010; Muthén, B. 2011). McDonald's Omega was therefore calculated based on loadings and error variances at the between-level. We will report the exact level of statistical significance for each statistical estimate where it is appropriate and report $p < .001$ if the level of significance is below that threshold.

3.4. Results

3.4.1. Compliance and Descriptives

We expected up to 2720 observations over the entire study period because the 80 participants were encouraged to plan at least two tasks for each of the 17 days of assessment using the e-diary. A total of 2651 tasks were planned, depicting an excellent compliance-rate of 97.46%. Since 15 participants never delayed the execution of a task, the following results are based on the 231 observed events of delay nested within 65 participants, because we were interested in observations of delay only. Frequencies of positive (positive response in terms of the criterion) and negative (negative response in terms of the criterion) responses to the five e-MAPS items are depicted in Table 2. Positive responses are found to be considerably less frequently reported for CA-items (item 1, item 4, item 5) than for SD-items (item 2, item 3). Based on the P-indicator, 172 events of delay (74.5%) do not fulfill the criteria for

procrastination, whereas 59 delays (25.5%) are deemed instances of procrastination. Among those participants who delayed the execution of a task (*n* = 65), the F-indicator (*M* = 0.91, *SD* = 1.52, range: 0 – 10) reveals that for 33 participants (41.3%), none of the observed delays was considered procrastination. For the remaining 32 participants who delayed the execution of a task, the F-indicator reveals that at least one delay was an instance of procrastination based on our criteria. In detail, 19 participants reported one delay, eight participants reported two delays, three or four delays were observed for two participants, and one participant reached ten delays fulfilling the criteria for procrastination.

Table 2. Frequencies of e-MAPS item-response-categories for the 231 delays observed within *n* = 65 participants.

e-MAPS item	Positive response [a] Frequency [%]	Negative response [b] Frequency [%]
Item 1 (CA)	55 [23.8]	176 [76.2]
Item 2 (SD)	111 [48.1]	120 [51.9]
Item 3 (SD)	95 [41.1]	136 [58.9]
Item 4 (CA)	58 [25.1]	173 [74.9]
Item 5 (CA)	48 [20.8]	183 [79.2]
P-indicator [c]	172 [74.5]	59 [25.5]

Note. CA = cognitive-affective appraisals of delay; SD = situational determinants of delay; P-indicator = 1 if (sum of CA-items > 0) AND (sum of SD-items > 0); P-indicator = 0 if (sum of CA-items = 0) AND / OR (sum of SD-items = 0).
[a] A positive response in terms of the predefined criteria for procrastination (coded 1), was a "yes" response to item 1, item 4, and item 5 as well as a "no" response to item 2 and item 3. [b] A negative response in terms of the predefined criteria for procrastination (coded 0), was a "no" response to item 1, item 4, and item 5 as well as "yes" response to item 2 and item 3. [c] Delays deemed as instances of procrastination based on the P-indicator.

3.4.2. Exploring the underlying factorial structure

To explore the factorial structure of the e-MAPS, a single-level EFA was conducted based on the tetrachoric correlations between the five e-MAPS items

(see Table 1). These tetrachoric correlations indicate the strongest positive associations between the three CA-items, representing the cognitive-affective appraisals of the delay under consideration. The SD-items, representing the situational demands required to consider a delay procrastination, are only weakly correlated (r_t = .29). Because both SD-items cover distinct situational circumstances that are unlikely to be met for one event of delay at the same time, a weak correlation seems reasonable.

With r_t = .55, the strongest association between CA-items and SD-items was observed between the first item (CA, *unnecessary criterion*) and the third item (SD, *circumstances criterion*); this finding will be discussed in detail later. The remaining two CA-items are weakly correlated with the SD-items.

Unfortunately, SPSS only provides the Kaiser-Meyer-Olkin criterion (KMO) as an estimate for the amount of shared variance between items when conducting EFA. Because this fit index would have to be estimated at the single-item level before calculating the tetrachoric correlations, it is not useful for our approach. However, Bartlett's test of sphericity $\chi^2(10) = 713.40$, $p < .001$ indicated that correlations between items were sufficiently large for EFA.

Eigenvalues suggested the extraction of two factors (eigenvalue > 1). The initial eigenvalues of the first two factors accounted for 74.94% of the total variance, with the first factor accounting for 46.85% (42.39% after extraction) and the second factor accounting for 28.09% of the variance (17.23% after extraction). Because we suggested that the factors underlying the e-MAPS might be correlated, we used an oblique rotation technique. Rotated factor loadings for the items (depicted in Table 3) thus represent the standardized partial regression weights of the observed variable (item) on the underlying factor.

Although the two SD-items are unambiguously allocated to the second factor, the fourth and the fifth item (CA-items) are unambiguously allocated to the first factor. Based on our theoretical preconception of criteria for the assessment of behavioral procrastination, we argue that our SD-items contribute to the clarification of the situational preconditions under which the delay occurred. Their mutual relationship to the second factor seems to support this idea. Similarly, the common contribution of the fourth and fifth items to the first factor is in line with the conception that this factor covers the cognitive-affective appraisal of the delay under consideration. While the explanation for the emergence of these loadings seems straightforward, the meaning of the cross-

loading for the first item is not. This item represents the criterion that a delay should be unnecessary to qualify as procrastination and loads on both factors (loading of .81 for factor 1; loading of .56 for factor 2). A cross-loading can be deemed problematic in terms of a simple factor-structure.

TABLE 3. Rotated Factor Loadings and Item-Factor Correlations for Single-level Exploratory Factor Analysis with Oblique Rotation of e-MAPS Items based on Tetrachoric Correlations.

	Factor 1	Factor 2
Item 1	.814 [.879]	.561 [.655]
Item 2	-	.545 [.530]
Item 3	-	.629 [.641]
Item 4	.904 [.886]	-
Item 5	.610 [.607]	-

Note. Oblique rotation was used to allow for correlated factors. An item loading on the respective factor represents the standardized partial regression weights of the observed indicator (item) on the underlying factor. Loadings < .30 were suppressed, correlations between indicators and factors presented in brackets.

In reality, procrastination is not a simple but rather a complex construct and we assume that the cross-loading of the first item is of practical relevance for covering this complexity. First, whether a delay is objectively necessary is crucially influenced by the situational prerequisites under which the delay occurs. Second, to evaluate whether the delay is (un-)necessary, the individual has to make a cognitive evaluation of the prevailing situational particulars. It is therefore reasonable that both (cognitive- and situational) construct-relevant aspects influence responses to the first item. Consequently, the analysis of the rotated factor loadings leads us to address the first factor as the cognitive-affective appraisal component and the second factor as situational precondition component, both contributing to the assessment of momentary behavioral procrastination. However, the factors are weakly correlated (r = .12).

3.4.3. Estimation of measurement reliability and item variability

A MCFA was conducted to estimate McDonald's Omega (ω) as an indicator of the overall reliability of measurements using the e-MAPS. Calculating ω in a meaningful way requires each indicator (item) to have unique loadings and error variances. Because this is not possible for binary indicators at the within-level (error variances are not freely estimated), the reliability of measurements using the e-MAPS was estimated for the between-level only. The resulting reliability estimate was ω = .80 (*SE* = 0.16) covered by a 95% confidence interval between .49 (lower bound) and 1.0 (upper bound).

3.4.4. Convergent validity of the e-MAPS

To explore convergent validity, we correlated the F-indicator with the aggregate scores of the TPS-d and APSI-d subscale. The aggregate scores of the TPS-d and APSI-d were moderately correlated (r = .50, p < .001) in our sample. Correlations with the F-indicator were moderately positive (TPS-d: r = .38, p = .002; APSI-d: r = .45, p < .001), supporting the convergent validity of the e-MAPS. Further support for this interpretation comes from a Mann-Whitney test (U = 556.0, p = .03), indicating that the frequency of observed procrastination (F-indicator) was higher for participants with a high tendency to procrastinate (TPS-d score ≥ *Mdn* = 47.0, n = 39) than for participants with a low tendency to procrastinate (TPS-d score < *Mdn* = 47.0, n = 38). In addition, a Mann-Whitney test (U = 565.5, p = .04) indicated that the frequency of observed procrastination (F-indicator) was higher for participants with a high APSI-d score (> *Mdn* = 1.67, n = 38) than for participants with a low APSI-d score (≤ *Mdn* = 1.67, n = 39).

3.5. Discussion

This study provides preliminary evidence that the e-MAPS is a useful instrument to discriminate between delays that qualify as procrastination and delays that do not, and that variability in delay patterns between persons is assessed reliably. Examination of the factor structure revealed that the five e-MAPS items covered two latent components (factors). Thus, the findings from EFA empirically support our theoretical preconception that situational determinants (SD) and cognitive-affective (CA) appraisals are equally relevant in

differentiating delays that qualify as procrastination from other (strategic) forms of delay.

Specifically, the three items conceived to assess whether an observed delay was unnecessary, irrational and evoked subjective discomfort, condensed to one mutual (CA) component. This component reflects the major differences between procrastination and other forms of delay, as Klingsieck (2013b) clarified that being unnecessary, irrational and accompanied by subjective discomfort are attributes unique to procrastination. The items of established self-report scales refer to acts of delay or postponement but do not cover the key characteristics of procrastination in the wording of their items (Klingsieck, 2013b). Therefore, these scales assess participants' average tendency to engage in dilatory behavior, but not procrastination in a strict sense. The e-MAPS covers each of these characteristics in the CA-component and therefore ensures that an assessed delay can be considered procrastination in the conceptualized way.

Moreover, the remaining two e-MAPS items cover situation or context-specific prerequisites important to the distinction between strategic delays and procrastination. These items mapped on the second latent (SD) component. More importantly, the cross-loading of the first item on the SD-component illustrates the interrelation between situational prerequisites and cognitive appraisals of the delay. As previously stated (Gollwitzer & Wieber, 2010), to judge whether a delay is (un-)necessary, one must examine whether an individual had the objective opportunity to execute the intended behavior. The positive cross-loading of our first item is of significance in this respect because it suggests that participants' response patterns produced a meaningful covariance between indicators of situational circumstances and their cognitive appraisal. This is of utmost importance, as it shows that the e-MAPS validates the reciprocal influence of external and internal factors on behavioral procrastination. Proxies previously used to assess behavioral procrastination ignore this mutual relationship.

In sum, EFA results indicate that the CA-component and the SD-component both contribute to a sound decision regarding whether a delay is or is not procrastination. This is remarkable because although differences between procrastination and other forms of delay have been repeatedly acknowledged (Corkin et al., 2011; Grunschel et al., 2013b; Klingsieck, 2013b), to our

knowledge, the e-MAPS is the first instrument to discriminate between events of behavioral procrastination and pure delay.

However, the e-MAPS not only provides information on the type of delay observed but also delivers an aggregate measure to quantify how frequently participants procrastinated over the study period. The modest positive association between the F-indicator and the TPS-d and APSI-d aggregate scores resembles the associations usually found between behavioral measures and self-report scales assessing procrastination (e.g., Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001; Tice & Baumeister, 1997). Remember that the e-MAPS assesses the behavioral manifestation of procrastination in daily life, within the current situation, whereas established self-report scales assesses only some cross-temporal proneness to engage in dilatory behavior. Nevertheless, the information contained in the aggregate scores overlaps conceptually and allows for the interpretation of our findings in terms of convergent validity. The fact that participants who scored high versus low on the self-report scales reported more events of delay fulfilling the criteria for procrastination, further supports this conclusion.

These results may seem to endorse Steel's (2007, p. 67) conclusion that evidence indicates sufficient "cross temporal and situational stability" to conceptualize procrastination as trait-like construct. However, this conclusion is short sighted because we assessed single events of procrastination occurring in different situations, and the numerical aggregate of these events was larger for people who scored high on self-report scales. Moon and Illingworth (2005) found the same curvilinear trend in behavioral procrastination over the course of a semester for students who varied in their initial levels of self-reported procrastination. Other authors support the idea that the mechanisms relevant to the manifestation of behavioral procrastination might be more dynamic, time- and context-dependent, than previously suggested (e.g., Blunt & Pychyl, 2000; 2005; DeWitte & Schouwenburg, 2002; Steel & König, 2006). Implementing the e-MAPS over a longer period of time (the course of an academic semester) and inspecting whether a decrease in events of procrastination can be observed before some deadline (at the end of term) could provide evidence for the notion that time, situation, and context have a considerable influence on the behavioral manifestation of procrastination. This would provide further support of the e-MAPS's external validity as well. However, we emphasize that the e-MAPS

requires participants to set their own deadlines for the execution of each intended goal-directed action, and that it stands out from measures previously used to capture behavioral procrastination in this regard.

The indirect assessment of procrastination allowed by the implementation of the e-MAPS might also be valuable in treatment-contexts. Rozental and Calbring (2014) discuss the relevance of differentiating between cases of procrastination that are of clinical relevance and occasional instances of procrastination that might be negligible. We believe that our F-indicator provides a practical solution for this problem. It incorporates only cases that fulfill the predefined criteria for procrastination and provides an indicator of the frequency of their occurrence. Therefore, if a participant reports delays fulfilling the criteria for procrastination very frequently, this indicates a severe form of procrastination. Some treatment programs for (academic) procrastination include time for exploring individual patterns in procrastination behavior, such as writing a diary or protocol for dilatory behavior (e.g., Engberding et al., 2011; Grunschel et al., 2018; for an overview, see contributions in Schouwenburg et al., 2004). The implementation of the e-MAPS to these programs would be effortless, and it is even dispensable to use an ESM-framework for such purposes. Notwithstanding that the e-MAPS was applied on smartphones in our study, an additional strength of this instrument is that it is also applicable as a paper-pencil version filled out on a daily basis. This would simply require participants to list all actions that have been intended but were delayed by the participant that day. The paper-pencil version of the e-MAPS can then be used to test whether these retrospectively assessed delays fulfill the criteria for procrastination.

3.5.1. Limitations

We would like to address some aspects that limit the inferences that can be drawn from our study. First, as addressed in the methods section, an SEM approach would be suitable to explore the factor structure of the e-MAPS because responses to items are nested in events of delay that are nested in persons. Unfortunately, the number of observed delays per participant and the number of events that qualified as procrastination was too small in our study to allow for meaningful analysis at the within-person level. Second, when conducting a single-level EFA based on tetrachoric correlations, SPSS does not

allow for a reliable estimation of the amount of shared variance between items, which is why we cannot report sophisticated fit-indices for our EFA here. However, the factor-structure provided by the single-level EFA does fit our theoretical conceptualizations. We are convinced that future studies can ascertain the results provided here, using an ESEM-approach (Asparouhov & Muthén, 2009) based on a larger sample that includes more events of delay and behavioral procrastination, respectively.

Third, although the MCFA approach is suitable for the estimation of reliability at the within-person level (Bolger & Laurenceau, 2013; Geldhof et al., 2014), item loadings and error variances must be allowed to vary across items to calculate McDonald's omega. Hence, an estimate for within-person reliability of measurements cannot be provided here, because the binary response format of our items restricts the single-item error variances to a fixed quantity at the within-level of an MCFA model (Muthén, B. 2011; Raykov et al., 2010). However, based on the analysis conducted, we can attest that the e-MAPS assessed variability in delay patterns between persons reliably.

Moreover, because our measure is the first instrument explicitly developed to assess the manifestation of procrastination in daily life, proving the validity of the measurements is difficult. As mentioned before, we believe that the positive associations with the applied self-report scales can serve as a first indicator of the validity of the e-MAPS measurements. Nonetheless, it would be worthwhile to prove coherence between assessments of procrastination based on the e-MAPS and behavioral measures for the assessment of procrastination. Unfortunately, we did not include such behavioral proxies in our study design, but we strongly recommend doing so for future exploration of the e-MAPS's validity.

In addition to having several shortcomings, measures previously used to assess behavioral procrastination have the advantage of being observational in nature. The assessment of behavioral procrastination based on the e-MAPS relies on self-reports, which have been criticized for being influenced by participants' potential unwillingness to provide accurate information about their maladaptive behavior (Steel et al., 2001). However, we considered these issues carefully during scale construction. Although our measure relies on self-reports of dilatory behavior, it is unnecessary that participants directly evaluate whether they consider a delay to be procrastination, which might evoke negative

associations in terms of being socially unacceptable. Furthermore, cognitive access to a common concept about what qualifies a delay as procrastination is not necessary when responding to the e-MAPS. Instead, our five-item scale provides an appropriate workaround because it does not require participants to have a coherent knowledge structure about procrastination. Rather, we address the problem by using indirect assessments for the presence or absence of aspects relevant for considering a delay as procrastination.

3.5.2. Conclusions

The e-MAPS is an instrument for assessing the manifestation of behavioral procrastination in daily life. Specifically, this five-item short scale is the first validated tool to discriminate between delays that fulfill the criteria for procrastination and those that do not. Multiple assessments provide the possibility of computing an aggregate score of procrastination frequency, which is conceptually similar to the aggregate scores of established self-report scales. Finally, the e-MAPS expands our toolbox and facilitates the implementation of longitudinal designs. Research assessing the dynamic time and context dependent processes (causally) linked to procrastination (assessed by the e-MAPS) would provide insights regarding the causes and consequences of engaging in procrastination behavior. We hope that this instrument will encourage research on the intra-individual processes involved in the occurrence of procrastination.

3.6. Footnotes

[1] The scale was first developed in German. The wording of the original items was carefully selected to resemble the meaning of the definitions that were derived from the literature published in English. A native English speaker fluent in German translated the scale into English. The translation was made for the purpose of this publication only. No back translation has been performed yet. The e-MAPS original items are presented here:

"Bitte beantworten Sie die folgenden fünf Aussagen mit Ja / Nein: (1) Wenn ich ehrlich bin, ist es unnötig, die Bearbeitung dieser Aufgabe aufzuschieben. (2) Ich schiebe die Bearbeitung der Aufgabe auf, weil mir eine andere wichtige Aufgabe dazwischen-gekommen ist. (3) Das Aufschieben der Aufgabe ist durch äußere Umstände begründet, auf die ich keinen Einfluss habe. (4) Es ist im Grunde unvernünftig, die Bearbeitung dieser Aufgabe aufzuschieben. (5) Wenn ich darüber nachdenke, löst es ein gewisses Unbehagen in mir aus, dass ich die Bearbeitung dieser Aufgabe aufschiebe."

Author Note: The wording of the e-MAPS items was first presented at the 10th Biennial Procrastination conference (July, 2017), Chicago, IL, USA.

3.7. References

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Chapter 4

4. Task Ambiguity and Academic Procrastination: An Experience Sampling Approach

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4.1. Abstract

Procrastination is thought to be affected by trait-based and by situational, or task-specific determinants. Situational and task-specific influences on students' procrastination behavior have rarely been studied. Most research has examined trait-based individual differences in students' general procrastination tendencies. This study used an adaptive experience sampling approach to assess students' (*N* = 88) task-related perceptions of ambiguity and their situation-specific procrastination behavior during exam preparation six times a day for seven days (*n* = 3581 measurements). Results revealed that 30% of all intended study sessions were procrastinated. The risk that study sessions were procrastinated increased with students' task-related ambiguity perceptions. Individuals' average risk of procrastinating study sessions was further predicted by their procrastination tendency and conscientiousness assessed at baseline. The findings suggest interventions that promote students' ability to self-regulate but also modify tasks and instructions. Further implications and suggestions for future research are discussed.

4.2. Introduction

4.2.1. Background

Numerous studies have demonstrated positive relationships between students' self-regulation abilities and their academic achievement (Nota et al., 2004; Richardson et al., 2012; Schneider & Preckel, 2017). Failures in self-regulation may manifest in procrastination behavior (e.g., DeWitte & Lens, 2000; Steel, 2007; Wolters, 2003), which has detrimental effects on students' academic performance and well-being (e.g., Beutel et al., 2016; Klassen et al., 2008; Richardson et al., 2012; Steel et al., 2001; Tice & Baumeister, 1997). Pronounced procrastination tendencies have been most notably associated with lower conscientiousness or increased impulsivity at the trait-level (for reviews, see Klingsieck, 2013; Steel, 2007; van Eerde, 2003). Further research has found pronounced procrastination tendencies to be associated with low self-esteem, lack of confidence in one's ability to succeed at tasks of a particular type or domain (i.e., low self-efficacy beliefs), and with work- or mastery-avoidance orientations (Harrington, 2005; Howell & Watson, 2007; Klassen et al., 2008; Wolters, 2003). Thus, students' procrastination tendency appears to be affected by self-beliefs and attitudes that limit their self-regulatory efforts, especially when tasks appear difficult or demanding. This inference has been further supported by studies that found students were more likely to procrastinate on tasks they perceived as aversive, unpleasant, difficult, or effortful (e.g., Blunt & Pychyl, 2000; Ferrari & Scher, 2000; Lay, 1992).

Accordingly, procrastination behavior has been suggested to represent an impulsive avoidance response to (affectively) negative experiences that occur when task demands appear to exceed individuals' resources, capacities, or abilities (Blunt & Pychyl, 2000; Flett et al., 1995; Sirois & Pychyl, 2013; Tice et al., 2001). Research to support this premise would need to extend existing findings on trait-based individual differences in procrastination tendencies to identify complementary task- or context-specific constraints on individuals' self-regulatory capacities that may contribute to the actual occurrence of procrastination behavior. Few recent studies have shown that the day-level incidence of procrastination increases when individuals' self-regulatory capacities are limited by emotional or (psycho-)physiological states (e.g., Kühnel et al., 2016; Pollack & Herres, 2020; van Eerde & Venus, 2018). The number of

studies that have examined the influence of task-related demands on students' procrastination behavior remains limited. Existing studies indicated that students were more likely to procrastinate when they had the impression that the information (about goals, sequential actions, or means) required to accomplish a task was incomplete, vague, or ambiguous (Ackerman & Gross, 2005; Blunt & Pychyl, 2000; Hoppe, Preissler, & Förster, 2018; Hoppe, Prokop, & Rau, 2018). However, these findings related to individual differences in retrospective self-reports about students' task-related procrastination tendencies (e.g., for their final thesis; Hoppe, Preissler, & Förster, 2018). Thus, it cannot be determined whether procrastination behavior was induced when students perceived the resources available in a given situation to be insufficient to meet the task-related demands.

The present study aimed to extend existing findings on individual differences in procrastination tendencies and to investigate whether the actual occurrence of procrastination behavior would be affected by students' momentary perceptions of ambiguity about studying for an exam. The study was designed to contribute to the existing body of research in three ways. First, we used an adaptive experience sampling approach to capture students' perceptions of ambiguity and their actual procrastination behavior for intended study sessions six times a day for seven days during exam preparation. Second, we examined whether students' perceptions of ambiguity varied across study sessions (i.e., within-person) and whether this session-specific variance would predict the actual occurrence of procrastination behavior. Third, we investigated whether students' general procrastination tendency and conscientiousness predicted individual differences in their procrastination behavior during exam preparation. We have finally explored whether person-level determinants (i.e., procrastination tendency and conscientiousness) moderated the effect of students' ambiguity perception on their procrastination behavior.

4.2.2. Previous Research on Procrastination

Procrastination describes the behavior of unnecessarily delaying to work on an important task contrary to one's initial intention, despite being aware that this might come to one's own disadvantage (Klingsieck, 2013; Simpson & Pychyl, 2009). Procrastination has been most often studied in academic contexts, where many students procrastinate frequently and consider their behavior problematic

(Beswick et al., 1988; Day et al., 2000; Schouwenburg, 2004; Solomon & Rothblum, 1984). Within the German population, students and pupils between 14 and 29 years of age reported stronger procrastination tendencies than older age groups and working peers (Beutel et al., 2016). About 30% of respondents in a sample of university students indicated that they procrastinate a lot or very much on academic tasks such as studying for exams or writing term papers (Day et al., 2000). Solomon and Rothblum (1984) have found students procrastinate very often or almost always when writing term papers (45%), studying for exams (28%), or completing reading assignments (30%).

Most studies that have investigated why students engage in such dysfunctional behavior followed one of two complementary perspectives. From a differential psychology perspective, most research linked between-person differences in students' self-reported procrastination tendencies to other trait-like variables (for reviews, see Klingsieck, 2013; Steel, 2007; van Eerde, 2003). This line of research has regularly revealed that increased procrastination tendencies were related to lower levels of conscientiousness and higher levels of neuroticism or impulsivity (Ferrari & Emmons, 1995; Johnson & Bloom, 1995; Lee et al., 2006; Schouwenburg & Lay, 1995; Watson, 2001). Sometimes, procrastination has even been declared a trait-like construct in itself (Ferrari, 1991; Ferrari, 2004; Schouwenburg, 2004).

Another line of research supports the perspective that procrastination results from the failure to self-regulate one's cognition, motivation, and behavior to reach an aspired goal (e.g., DeWitte & Lens, 2000; Howell et al., 2006; Wolters, 2003). Self-regulation theories (e.g., Boekaerts, 1999; Pintrich, 2004; Winne & Hadwin, 1998; Zimmerman, 2002) generally agree that individuals' goal-directed behavior (or performance) is controlled by complex cognitive-affective processes that mediate between individual dispositions (e.g., personal characteristics, knowledge, or skills) and situational influences (e.g., current demands or available resources). Accordingly, procrastination behavior has been proposed to reflect an impulsive avoidance response to the (affectively) negative experience that occurs when task demands appear to exceed an individual's resources, capacities, or abilities (Blunt & Pychyl, 2000; Flett et al., 1995; Sirois & Pychyl, 2013; Tice et al., 2001). This proposition was partially supported by empirical evidence for an association between students'

procrastination tendency and their experience of negative emotions, or their inability to regulate these emotions properly (Eckert et al., 2016; Lay, 1992; McCown et al., 2012; Pollack & Herres, 2020; Rebetez et al., 2015). Except for a diary study that found increased experiences of negative emotions on one day predicted increased procrastination tendencies for the following day (Pollack & Herres, 2020), most of this research has been limited to the examination of individual differences. It remained largely unconsidered that the negative affective state should reflect an individual's experience of not being able to achieve an aspired goal by means of available resources given situational conditions (e.g., task-related demands), or that it would require great effort (cf. Ellsworth & Scherer, 2003; Frijda et al., 1989; Lazarus, 1993; Pekrun, 2006).

Procrastination behavior would thus be expected in situations where task-related demands appear to exceed the individual's capacity (or perceived control; Pekrun, 2006; Skinner, 1996) to bring about the desired outcome. Previous studies demonstrated that students' procrastination tendency was inversely related to their ability, competence, and efficacy beliefs (e.g., Howell & Watson, 2007; Klassen et al., 2008; Wolters, 2003). However, other research found considerable within-person variability in students' ability, competence, or efficacy beliefs as a function of tasks, topics, or context-specific influences (e.g., Dietrich et al., 2017; Malmberg et al., 2013; Vancouver & Kendall, 2006). Few studies examined task- or context-specific influences on the occurrence of procrastination behavior. One longitudinal study found that students' self-efficacy decreased when they failed to meet their weekly learning goals, which increased their self-reported procrastination incidence (Wäschle et al., 2014). A diary study in an occupational context revealed that high trait self-control attenuated the negative impact of poor sleep quality on the self-reported incidence of procrastination at the day level (van Eerde & Venus, 2018). Another diary study has shown that the self-regulatory effort required to deal with job-related tasks was positively related to the self-reported procrastination incidence at the day level (Prem et al., 2018). The latter finding suggests that participants' procrastination behavior was affected by their ability (or willingness) to invest the effort needed to meet the task-related demands.

Some previous studies have shown that students were more likely to procrastinate on tasks that they perceived as unpleasant, difficult, or effortful (e.g., Blunt & Pychyl, 2000; Ferrari & Scher, 2000; Lay, 1992). Blunt & Pychyl's

(2000) findings further revealed that students' procrastination behavior was associated with a high level of task aversiveness due to a perceived lack of control and uncertainty about how to proceed. Accordingly, procrastination behavior should be more likely to occur when an individual experiences uncertainty about the actions or the means required to accomplish one's task successfully.

4.2.3. Ambiguity in the Context of Action Regulation

Action- and self-regulation theory agree that individuals need knowledge to successfully monitor, adapt, and control their (study) behavior (e.g., Hacker, 2003; Pintrich, 2004; Winne & Hadwin, 1998; Frese & Zapf, 1994). Individuals need knowledge about the goal, the conditions under which the goal has to be accomplished, and the methods required to reach this goal (Breaugh & Colihan, 1994; Hacker, 2003; Pintrich, 2004; Zacher, 2017). When the knowledge necessary to perform a task is lacking, perceptions of ambiguity or uncertainty may arise (Kagan, 1972; Kahn et al., 1964), as this impairs the execution of goal-directed actions (Frese & Keith, 2015; Hacker, 2003). Notably, insufficient knowledge about methods or performance criteria constrains the ability to direct one's behavior toward achieving the desired outcome (Pintrich, 2004; Tice & Bratslavsky, 2000; Skinner, 1996).

Introducing the concept in the field of work and organizational psychology, Kahn and colleagues (1964) identified three types of ambiguity: (1) ambiguity about work methods (i.e., knowledge of procedures necessary for the accomplishment of a task), (2) ambiguity about the sequencing of activities (i.e., setting priorities, determining which of the competing tasks should be completed first), and (3) ambiguity concerning performance criteria (i.e., knowledge about the performance that will be judged as being satisfactory). In the occupational context, ambiguity describes the multifaceted experience of task-specific demands that have been frequently related to stress, poor performance, dissatisfaction, or depression (for reviews, see Gilboa et al., 2008; Schmidt et al., 2014; Tubre & Collins, 2000).

A different line of research has linked perceptions of task-related ambiguity to procrastination behavior. Harris and Sutton (1983) proposed that both personal characteristics and task characteristics such as difficulty, appeal, ambiguity, and deadline pressure should be considered to provide a

comprehensive understanding of procrastination behavior. Paden and Stell (1997) described perceptions of ambiguity as one facet of perceived task difficulty due to unclear or insufficient instructions. An online survey in the U.S. has shown that faculty members' procrastination behavior was related to their perception of clarity (vs. ambiguity) about what was required to complete their tasks and how to proceed (Ackerman & Gross, 2007). Similar results were reported for students working on large-scale assignments (Ackerman & Gross, 2005). Another retrospective online survey found that students reported lower procrastination tendencies and stronger work engagement when goal-setting agreements were regularly recorded during their thesis supervision, with more clarity (or less ambiguity) about the approach mediating these associations (Hoppe, Prokop, & Rau, 2018). Additionally, prospective perceptions of ambiguity about working toward their final thesis were found to predicted students' procrastination tendency after four to seven months (using a cross-lagged panel design, Hoppe, Preissler, & Förster, 2018).

In summary, these findings suggest that ambiguity perceptions reflect individuals' subjective assessment of their ability to cope with the demands placed by their tasks. However, research has primarily focused on the examination of individual differences in the relationship between task-related ambiguity perceptions and students' retrospective reports on their procrastination behavior. Thus, there is limited evidence to support the premise that procrastination will be induced in situations where an individual perceives that available resources may be insufficient to meet task-related demands and achieve an aspired outcome.

4.2.4. The Present Study

The present study was guided by the premise that the actual occurrence of procrastination behavior should depend on both persistent individual characteristics at the trait-level and more momentary task- or context-specific influences (cf. Sirois & Pychyl, 2013; Tice et al., 2001; van Eerde, 2003). We aimed to extend previous research in three ways. First, previous research has either captured students' procrastination behavior by retrospective questionnaires or by the observation of temporal discrepancies (e.g., delayed submissions or differences between time planned and spent on learning) that were only weakly to moderately related to their general procrastination

tendencies (e.g., DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Steel et al., 2001). The present study implemented an experience sampling approach that captured students' procrastination behavior using an adaptive e-diary six times a day for seven days while studying for an exam. This approach provided close-to-real-time measurements of students' self-reported procrastination behavior for intended study sessions. Second, existing research related perceptions of ambiguity in task demands to procrastination behavior that was reported retrospectively for several weeks (e.g., Ackerman & Gross, 2005; Hoppe, Prokop, & Rau, 2018), but not in the context of studying for an exam. The present study aimed to investigate the influence of situation-specific perceptions of task-related ambiguity on the actual occurrence of procrastination behavior during exam preparation. Third, the current study examined relationships between momentary perceptions of task-related ambiguity and students' actual procrastination behavior while accounting for individual differences that may be expected based on students' general procrastination tendency and conscientiousness.

We expected that students' task-related ambiguity perceptions vary across study sessions (i.e., within-person variability; Hypothesis 1). We further expected that the occurrence of procrastination behavior should be more likely when session-specific perceptions of task-related ambiguity exceed an individual's average ambiguity perception across study sessions (fixed effect; Hypothesis 2). In addition, individual differences in task-related ambiguity perceptions (i.e., differences in individuals' average ambiguity ratings across study sessions) should predict students' average risk to procrastinate. It was expected that procrastination would be more likely for students who perceive more ambiguity in their study-related tasks on average (Hypothesis 3). In addition, between-person differences in students' general procrastination tendencies and conscientiousness should predict students' average risk to procrastinate. The average risk to procrastinate studying for the exam should increase for students with stronger general procrastination tendency but decrease for more conscientious students (Hypothesis 4). We further expected individual differences in the effect of task-related ambiguity perceptions on students' procrastination behavior (random effect; Hypothesis 5). Finally, it will be examined whether between-person differences in general procrastination

tendency and conscientiousness moderate the association between students' ambiguity perceptions and their procrastination behavior.

4.3. Method

4.3.1. Sample and Procedure

Our sample consisted of N = 88 psychology students (83% female; M_{age} = 20.98 years, SD = 2.56, age missing for one participant; 88.6% aiming for a bachelor's degree) enrolled at one of two German universities. Participants were instructed to use an e-diary six times a day for seven days during the exam preparation period at the end of the term. In total, n = 3581 e-diary queries were completed, which results in a compliance rate of 96.89% based on n = 3696 potential measurements (88 students * 7 days * 6 daily measurements).[1]

Students were invited to participate in the study, personally addressing them within lectures or via social media. Students who agreed to participate and gave their informed consent were instructed to install the application (TMBP Technologies GmbH, 2019; P&T Testsystem, Version 1.14 for Android) on their smartphone and received a random user-code and password from (blinded) study supervisors to log into the e-diary and submit their data anonymously.

Participants were instructed in the handling of the e-diary and the calendar application that reminded them to complete the diary every two hours each day, with the first reminder set to alarm at 10 a.m. (12 a.m., 2 p.m., 4 p.m., 6 p.m.), and the last reminder set to 8 p.m. The interval was scheduled so that queries could be completed in between lectures. Provided that they scheduled study sessions for the late evening, students were encouraged to continue the diary after the 8 p.m. query. After this introduction, participants filled in paper-pencil questionnaires indicating demographic information, their exam(s) at the end of term (including dates), relevant personality traits, and general procrastination tendencies.

All students were informed in detail about the purpose and procedure of data collection, the use of the e-diary, and all data protection regulations of relevance for participation in advance. The materials and procedures used were noninvasive. Following local legislation and institutional requirements, ethical review and approval were not required for the study. The study followed international ethical standards (American Educational Research Association

[AERA], 2011). Participants were rewarded with participation credits, which are needed to fulfill their graduation requirements.

4.3.2. Measures

To avoid responses being biased, students' procrastination behavior had to be assessed without asking for "procrastination" explicitly. This was realized by the implementation of an adaptive e-diary design (see Figure 1). In total, *n* = 3581 e-diary queries were completed by the *N* = 88 participants. Measurements that have not been completed within 30 minutes after initiating the query (*n* = 57) have been excluded in advance (see Figure 2). The average time required to answer a query was 1.22 minutes (*SD* = 1.05; min. = 0.9; max. = 20.13) across the remaining *n* = 3524 measurements.

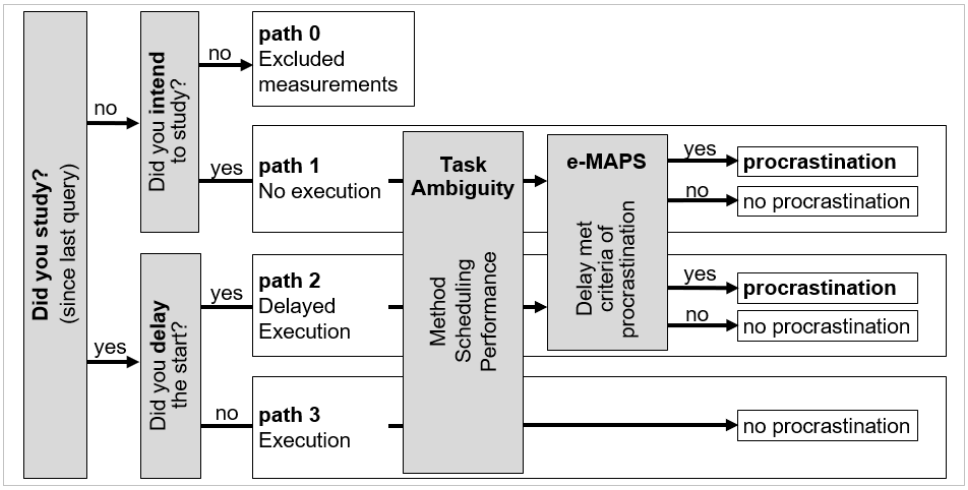

Figure 1. Description of the adaptive e-diary design. Responses to the first two questions resulted in different paths. Path 0 was excluded from the analyses. In path 1, 2, and 3, task ambiguity perceptions were assessed. In path 1 and 2, task ambiguity items were followed by the e-MAPS (Wieland et al., 2018). The dependent variable (procrastination vs. no procrastination) was computed combining the information resulting from the paths and the e-MAPS.

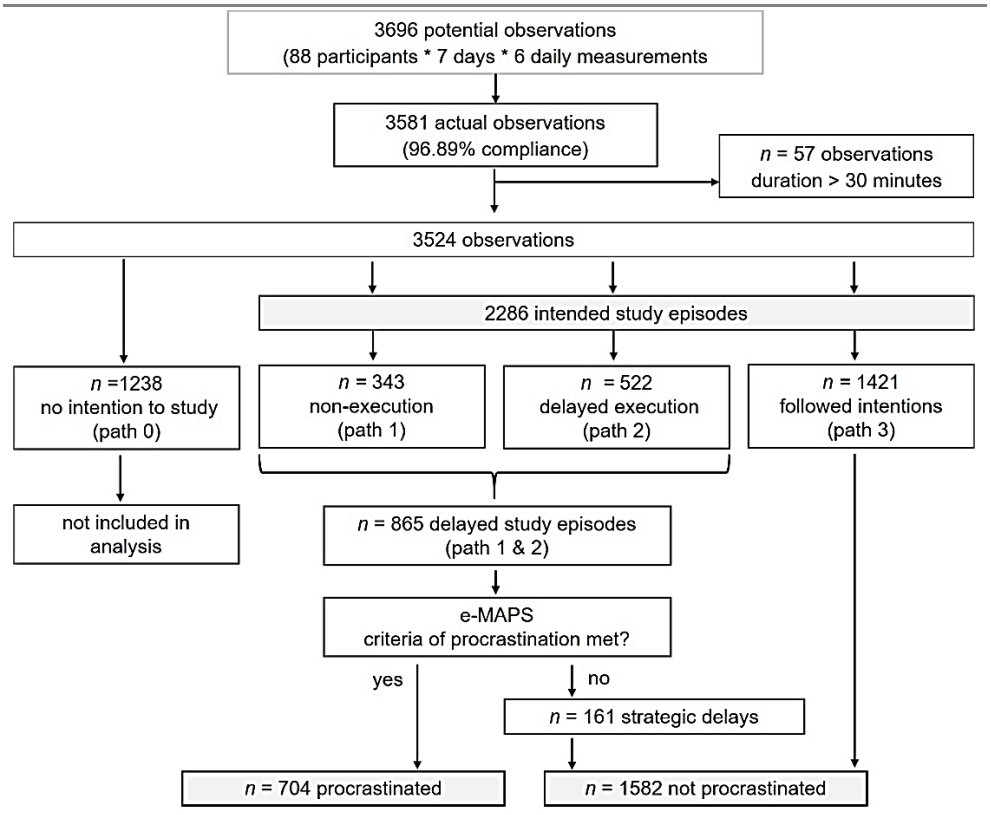

Figure 2. Data flow indicating the number of measurements provided by the participants (Level 2; *N* = 88), and the subset of Level 1 measurements that have been included in the analyses conducted to answer our research questions. In total, *n* = 2286 Level 1 observations (intended study sessions) were included (*n* = 704 procrastinated vs. *n* = 1582 not procrastinated).

Within the e-diary, each item appeared on the screen one after the other. At the beginning of each measurement, students indicated whether they had studied for their exam since the last measurement (yes; no). When they had studied, they were asked whether they had delayed initiating that study session (yes; no). In cases where students did not study for their exam, they were asked whether they had the intention to study (yes; no). Procrastination behavior necessarily involves a delay in the execution of goal-directed behavior contrary to one's original intention (Lay, 1986; Steel et al., 2001). Therefore,

measurements in which students indicated that they had no intention to study (path 0) were excluded from analyses (see Figure 2).

In the event that students intended to study but failed to follow their intention (path 1), studied but delayed to initiate studying (path 2), or realized their study intentions as planned (path 3), they were next presented with items assessing their perceptions of ambiguity for the tasks they had performed (or had intended to perform) since the last measurement. When students had intended to study but delayed the study session (n = 838 delays, path 1 or path 2), ambiguity items were followed by the ecological Momentary Assessment of Procrastination Scale (e-MAPS: Wieland et al., 2018). The e-MAPS determined whether reported delays met the criteria necessary to be classified as procrastination behavior (n = 704), or should not be classified as procrastination. For the analyses, delays that were not classified as procrastination (n = 161) were treated like study sessions that were not delayed (path 3), resulting in n = 1582 non-procrastinated study sessions. Figure 2 provides an overview of the data flow.

Procrastination Behavior

The ecological Momentary Assessment of Procrastination Scale (e-MAPS; Wieland et al., 2018) was used to determine whether the delay of a study session qualifies as procrastination behavior. The e-MAPS was developed as a tool for experience-sampling studies to identify delays fulfilling the criteria necessary to be classified as procrastination. Two items capture whether situational determinants (SD) provide a legitimate reason for the delay, whereas the remaining three items capture the cognitive-affective (CA) appraisal of the behavior (as being unnecessary, irrational, or associated with experiencing subjective discomfort). Students respond to each item by indicating whether the delay meets the specific criterion (yes; no). A delay meets the criteria for procrastination behavior when the situation does not provide a legitimate reason (*no* response to at least one of the SD-items), and when the delay meets at least one of the criteria covered by the items assessing the cognitive-affective appraisal (*yes* response to at least one of the CA-items). Based on these criteria, any delay of a study session was categorized as either fulfilling the criteria for procrastination or not. Delays that have not fulfilled the criteria were analyzed together with instances where students realized their study intentions as planned (see Figure 2).

Situational Task Ambiguity

Students' task-related ambiguity perception for each (intended) study session was assessed using four items selected from the German version (Schmidt & Hollmann, 1998) of Breaugh and Colihan's (1994) job ambiguity scale. The original job ambiguity scale consists of three subscales (work method, scheduling, and performance criteria ambiguity), including three items each (Breaugh & Colihan, 1994). We selected two items covering the experience of work method ambiguity: (1) "I am certain how to go about studying for the exam (the methods to use)" and (2) "I know how to get my work done (what procedures to use)." The first item was adjusted to the context of studying for the exam. The remaining two items were selected to cover the perception of scheduling ambiguity and performance criteria, respectively: (3) "I am certain about the sequencing of my work activities (when to do what)" and (4) "It is clear to me what is considered acceptable performance." Responses were provided on a seven-point rating scale (0 = *do not agree at all* to 6 = *agree strongly*) and have been recoded such that higher values indicate a stronger perception of task ambiguity. The average ambiguity rating across all items was (M = 1.99, SD = 1.22). A Multi-level Confirmatory Factor Analysis (MCFA) was used to provide information on the within- and between-level reliability of our measurements (see results section).

Baseline Measures: General Procrastination Tendency and Conscientiousness

The German short form of the General Procrastination Scale (GPS: Lay, 1986; GPS-K: Klingsieck & Fries, 2012) was used to assess students' general procrastination tendency at baseline. The GPS-K consists of nine items describing behaviors indicative of trait procrastination (e.g., "I often find myself doing tasks that I actually wanted to do days ago"), answered on a seven-point rating scale (0 = *very untypical* to 6 = *very typical*). The sample mean for the GPS was M = 26.34, SD = 9.65 (see Table 1). Cronbach's alpha was .84 in our sample, suggesting satisfactory scale reliability.

The German version of the Neo-Five Factor Inventory (NEO-FFI; Borkenau & Ostendorf, 2008; Costa & McCrae, 1992) was assessed at baseline (including all 60 items), using a seven-point rating scale (0 = *strongly disagree*, 6 = *strongly agree*). For the present study, we used responses to the 12-item conscientiousness subscale as a between-level predictor variable. The average

conscientiousness score was *M* = 45.61, *SD* = 8.22 (see Table 1) in our sample, Cronbach's alpha was .74, suggesting satisfactory scale reliability.

Covariates: Gender and Number of Semesters Studied

We control for the influence of gender and the number of semesters studied in our analyses. Both variables were assessed via self-report at baseline. Gender was included because female students reported lower tendencies for procrastination than did male students in previous studies (Gröpel & Steel, 2008; Steel & Ferrari, 2013). The total number of semesters studied has been included because it is likely that more experienced students perceive less ambiguity when preparing for their exams.

4.3.3. Data Analysis

The data used to predict students' risk to procrastinate studying for an exam have a two-level structure with *n* = 2286 measurements at the within-level (i.e., intended study sessions (*i*) at Level 1) nested in *N* = 88 participants at the between-level (i.e., students (*j*) at Level 2). We accounted for the nested data structure in the analyses using Mplus (Version 8.4; L. K. Muthén & Muthén 1998–2017). We first tested whether assessments of task-related ambiguity perceptions (a) reflected sufficient within-person variability between study sessions; (b) whether all four items load sufficiently on a single ambiguity factor, to summarize them both at the level of study sessions (Level 1, within-level) and at the level of students (Level 2, between-level); and (c) whether within- and between-person variability was reliably measured by the items. We therefore conducted an MCFA using maximum likelihood estimation with robust standard errors (MLR), fixing factor variances at 1.0, and freely estimating all factor loadings (Appendix A provides the Mplus Code).

A stepwise logistic multi-level regression approach was used to predict the risk for the occurrence of procrastination behavior in studying for the exam (Appendix B provides the Mplus Code). The outcome was the session-specific procrastination behavior captured using the e-diary (Y_{ij} = 1 *study session procrastinated* vs. Y_{ij} = 0 *study session not procrastinated*). All models were computed with random intercepts[2] using the MLR estimator, controlling the number of study semesters and gender.

Session-specific experiences of task ambiguity that were used as predictor variables had a within- and between component. The within-level component represents session-specific ambiguity perceptions clustered within students ($ambi_{ij}$) and centered at the person mean (i.e., cluster mean centered 'CMC' ($x_{ij} - \bar{x}_j$) – Enders & Tofighi, 2007), hereafter indicated as ($ambi_{CMCij}$). The between-level component represents students' average task-related ambiguity perception across study sessions ($amb_{.j}$) that was centered at the grand mean (i.e., grand mean centered 'GMC' ($x_j - \bar{x}$) – Enders & Tofighi, 2007), hereafter indicated as ($ambi_{GMCj}$). Students' procrastination tendency ($proct_j$), conscientiousness ($consc_j$), gender (sx_j), and the number of semesters studied ($nsem_j$) are used as predictor variables at the between-level (Level 2). Apart from gender, all these variables were centered at the grand mean, indicated by 'GMC' in the following.

Using a two-level random intercept threshold model, we have a continuous latent variable (η_{ij}) underlying the observed binary variable (Y_{ij}):

$$Y_{ij} = \begin{cases} 1 \text{ if } \eta_{ij} \geq 0 \\ 0 \text{ if } \eta_{ij} < 0 \end{cases}$$

The null model was computed to predict the risk (the log-odds) that students procrastinated study sessions (Y_{ij} = 1) when no predictor variable was added to the model: $\eta_{ij} = \beta_{00} + u_{0j}$

Where β_{00} is the intercept (i.e., the average log-odds that students procrastinate vs. not procrastinate study sessions), and u_{0j} is the Level 2 residual (i.e., the person-specific deviation from the average intercept) that is assumed to be normally distributed with a mean of zero. The random intercept (or threshold) variance $\mathrm{var}(u_{0j})$ indicates the between-person variance in the log-odds to procrastinate (vs. not to procrastinate) study sessions. There is no Level 1 residual term included in the equation, as the Level 1 residual variance cannot be freely estimated; it is implicitly fixed to the standard logistic distribution variance (i.e., $\pi^2/3$, see Muthén & Asparouhov, 2015; Schoeneberger, 2015). The proportion of between-person variance in the overall variance of the log-odds to procrastinate (vs. not to procrastinate) study sessions is expressed in the Intraclass Correlation Coefficient:

ICC = $\text{var}(\mu_{0j}) / [\text{var}(\mu_{0j}) + (\pi^2/3)]$.

To test our second and third hypothesis, we examined the extent to which session-specific deviations in students' ambiguity perception (at Level 1, ambi_{CMCij}), and between-person differences in students' average ambiguity perception (at Level 2, ambi_{GMCj}), predicted the risk for the occurrence of procrastination behavior (Model 1). The equation for Model 1 with fixed effects (i.e., slopes are assumed not to vary between students) becomes:

$$\eta_{ij} = \beta_{00} + \beta_{10}\,\text{ambi}_{CMCij} + \beta_{01}\,\text{ambi}_{GMCj} + \beta_{02}\,\text{nsem}_{GMCj} + \beta_{03}\,\text{sx}_j + \mu_{0j}$$

Because conscientiousness and students' general tendency for procrastination are closely related (e.g., Lee et al., 2006), both predictors were first added to the model separately to test our fourth hypothesis. Students' conscientiousness (consc_{GMCj}) was added in Model 2, whereas their procrastination tendency (proct_{GMCj}) was added in Model 3. Next, all predictors were added to the comprehensive model (Model 4):

$$\eta_{ij} = \beta_{00} + \beta_{10}\,\text{ambi}_{CMCij} + \beta_{01}\,\text{ambi}_{GMCj} + \beta_{02}\,\text{nsem}_{GMCj} + \beta_{03}\,\text{sx}_j + \beta_{04}\,\text{consc}_{GMCj} + \beta_{05}\,\text{proct}_{GMCj} + \mu_{0j}$$

According to our fifth hypothesis, the random effect for ambiguity perceptions ($u_{1j}\text{ambi}_{CMCij}$) was added to the comprehensive model (Model 5) to test for between-person differences in the effect ambiguity perceptions had on students' procrastination behavior.

$$\eta_{ij} = \beta_{00} + \beta_{10}\,\text{ambi}_{CMCij} + \beta_{01}\,\text{ambi}_{GMCj} + \beta_{02}\,\text{nsem}_{GMCj} + \beta_{03}\,\text{sx}_j + \beta_{04}\,\text{consc}_{GMCj} + \beta_{05}\,\text{proct}_{GMCj} + u_{0j} + u_{1j}\text{ambi}_{CMCij}$$

with the Level-2 variance-covariance matrix: $\begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} = \begin{bmatrix} \sigma^2_{u0} & \\ \sigma_{u01} & \sigma^2_{u1} \end{bmatrix}$

Finally, we examined whether the ambiguity slope ($\mu_{1j}\text{ambi}_{CMCij}$) varied as a function of individual characteristics. The cross-level interactions with

conscientiousness ($consc_{GMCj}$) and procrastination tendency ($proct_{GMCj}$) were entered separately as not to overload the model (Model 6 and Model 7).

4.4. Results

4.4.1. Descriptive Statistics and Preliminary Analysis of the Ambiguity Measure

It was tested whether there were significant differences between participating students depending on data collection sites (n = 66 students enrolled at University 1; n = 22 students enrolled at University 2). Participants did not differ significantly in terms of gender ratio (University 1, n = 53 female; University 2, n = 22 female, χ^2 = 1.313, p = .252), in their general procrastination tendency (University 1, M = 27.14, SD = 10.12; University 2, M = 23.95, SD = 8.13; t(86) = -1.338, p = .184), or in conscientiousness (University 1, M = 45.41, SD = 8.11; University 2, M = 46.23, SD = 8.70; t(86) = 0.402, p = .688). There was no significant difference in students' average ambiguity perception (t(86) = -0.778, p = .439) between University 1 (M = 2.02, SD = 1.03) and University 2 (M = 1.83, SD = 1.04). There was a significant difference in the number of semesters studied (t(86) = 4.101, p < .001) between students enrolled at University 1 (M = 2.67, SD = 2.32) and University 2 (M = 4.96, SD = 2.10). We controlled for potential differences in effects as a function of the number of semesters studied in subsequent analyses.

On average, each student completed 25.98 e-diary entries for intended study sessions. Table 1 provides means, standard deviations, intra-class correlations (ICCs), and level-specific correlations for item-specific ambiguity ratings, session-specific average ambiguity ratings, session-specific procrastination behavior, and person-level individual characteristics. Correlations are provided for both the level of study sessions (i.e., within-person associations at Level 1) and the individual level across study sessions (i.e., between-person associations at Level 2). Consistent with our first hypothesis, ICCs for the four ambiguity items ranged from .53 (item 2) to .71 (item 4), indicating that 30% to 50% of the variance in item-specific ambiguity ratings reflects variation between study sessions within individuals.

Table 1. *Descriptive Statistics (Mean, Standard Deviation, Range), ICC and Level-Specific Bivariate Correlations for Session-Specific Ambiguity Perceptions, Procrastination Behavior, and Person Characteristics.*

	M	*SD*	*Min; Max*	ICC	1	2	3	4	5	6	7	8	9
1 Ambi 1 w.m. [a]	1.80	1.28	0.0; 6.0	.558	—	.624***	.362***	.376***	.603***	.100**	—	—	—
2 Ambi 2 w.m. [a]	1.62	1.23	0.0; 6.0	.532	.906***	—	.380***	.388***	.621***	.078**	—	—	—
3 Ambi 3 sched. [a]	1.64	1.29	0.0; 6.0	.632	.815***	.803***	—	.300***	.434***	.036	—	—	—
4 Ambi 4 perf.crit. [a]	2.30	1.53	0.0; 6.0	.709	.697***	.650***	.690***	—	.445***	.078**	—	—	—
5 Ambi (average) [a]	1.99	1.21	0.0; 6.0	.722	.883***	.853***	.835***	.719***	—	.098***	—	—	—
6 Procrastinate [a, b]	0.31	0.46	0.0; 1.0	.253	.330**	.373***	.367**	.113	.238*	—	—	—	—
7 General proc [c]	26.34	9.65	3.0; 45.0	—	.099	.094	.183*	.590	.089	.516***	—	—	—
8 Consc (Neo) [c]	45.61	8.17	24.0; 61.0	—	-.163·	-.145	-.203	-.159	-.181	-.350***	-.537***	—	—
9 Nr. sem. studied [c]	3.24	2.45	1.0; 13.0	—	-.086	-.032	-.079·	-.105·	-.098	-.209*	.015	-.078	—
10 Gender [b, c]	0.17	0.38	0.0; 1.0	—	.134	.127	.191	.057	.108	.103	.175	-.278*	.067

Note. Correlations at Level 1 (n = 2286 session-specific measurements, 25.98 measurements per participant on average) above the diagonal, correlations at the between-person level (Level 2, N = 88 participants) below the diagonal. ICC = Intraclass Correlation Coefficient. Ambi 1 – Ambi 4 = Ambiguity Items; (w.m.) = work method; (sched.) = scheduling; (perf.crit.) = performance criteria); Ambi (average) = session-specific average over items assessing ambiguity perceptions (for correlations the respective item was not included in the average); Procrastinate = session procrastinated = 1 or not procrastinated = 0; General proc = general procrastination tendency assessed by the General Procrastination Scale; Consc (Neo) = conscientiousness assessed by the Neo-FFI; Nr. sem. studied = number of semesters studied; Gender (female = 0; male = 1). [a] Experiences at Level 1. [b] Binary variable (0, 1) correlations with continuous variables are biserial, correlations with binary variables are tetrachoric. [c] Person characteristics at Level 2. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

It appeared from the MCFA results (see Appendix C for a detailed description) that all four items used in the e-diary to assess situation-specific ambiguity perceptions loaded adequately on a single latent ambiguity factor (all loadings significant with $p < .001$) at the level of study sessions (Level 1, within-person) and at the level of students (Level 2, between-person). Referring to common cut-off criteria (Geiser, 2012; Hu & Bentler, 1999; Schermelleh-Engel et al., 2003), the theoretical model acceptably fit the data (RMSEA = .032; CFI = .991; TLI = .972; SRMR within = .020; SRMR between = .020). Reliability estimates for within-person measurements (McDonald's ω = .75 at Level 1) and between-person measurements (ω = .88 at Level 2) were satisfactory. Therefore, MCFA results (see Appendix C for further information) justified that item-specific ambiguity ratings were combined to form a single ambiguity indicator for students' session-specific ambiguity perceptions (Level 1) and for their average ambiguity perception across study sessions (Level 2). Note that each study session enters the following analyses as a single event at Level 1 (i.e., session-specific measurements have not been aggregated at the day level).

4.4.2. Main Analysis: Predicting Procrastination Behavior

With no predictor variables entered into the regression model (null model), the threshold risk for procrastinating (vs. not procrastinating) study sessions was $B = 1.186$ ($p < .001$), with an average probability of 23.4% for the occurrence of procrastination behavior. There was significant variance in the session-specific procrastination patterns between participants ($s^2 = 2.278$; $p = .001$; 95% CI [1.296, 3.260]), indicating that 41% of the relative risk to procrastinate (vs. not to procrastinate) study sessions was explained by between-person variance in students' study behavior (ICC = .41).

Results of Model 1 (see Table 2) show the effects of session-specific differences in students' ambiguity perceptions (Level 1, within-person) and of between-person differences in students' ambiguity perceptions (Level 2) on the risk that study sessions were procrastinated (vs. not procrastinated). The predicted probability for procrastinating study sessions was 22% when all predictors are equal to zero ($B = 1.272$; $p < .001$).[3]

As expected, the risk that a study session was procrastinated (vs. not) increased significantly when tasks were perceived as more ambiguous (i.e.,

Table 2. *Stepwise Multi-Level Models Predicting the Risk to Procrastinate (Y = 1) vs. Not to Procrastinate (Y = 0) Intended Study Sessions.*

	Model 1					Model 2					Model 3				
	Est. (*SE*)	*p*	95% CI		p.p.	*Est.* (*SE*)	*p*	95% CI		p.p.	*Est.* (*SE*)	*p*	95% CI		p.p.
			LL	*UL*				*LL*	*UL*				*LL*	*UL*	
Threshold	1.272 (0.196)	< .001	0.89	1.65	0.22	1.210 (0.181)	< .001	0.85	1.56	0.23	1.196 (0.168)	< .001	0.87	1.52	0.23
Ambi [a]	0.335 (0.102)	.001	0.14	0.53	0.28	0.335 (0.102)	.001	0.13	0.53	0.29	0.337 (0.103)	.001	0.14	0.54	0.30
Ambi [b]	0.337 (0.168)	.044	0.01	0.66	0.28	0.249 (0.172)	.149	-0.09	0.59	0.28	0.291 (0.157)	.064	-0.02	0.60	0.29
Sem [b]	-0.141 (0.066)	.033	-0.27	-0.01	0.20	-0.156 (0.063)	.041	-0.28	-0.03	0.20	-0.139 (0.056)	.013	-0.25	-0.03	0.21
Sex (m = 1)	0.424 (0.378)	.263	-0.32	1.16	0.30	0.107 (0.397)	.787	-0.67	0.89	0.25	0.102 (0.377)	.787	-0.64	0.84	0.25
Consci [b]	—	—	—	—	—	-0.060 (0.022)	.006	-0.10	-0.02	0.22	—	—	—	—	—
Gen. Proc. [b]	—	—	—	—	—	—	—	—	—	—	0.074 (0.015)	< .001	0.03	0.10	0.25
T-RV (μ_{0j})	2.043 (0.415)	< .001	1.23	2.86		1.799 (0.359)	< .001	1.09	2.50		1.464 (0.326)	< .001	0.83	2.10	
R^2 w (*p*)	0.013 (0.008)	.096				0.013 (0.008)	.097				0.013 (0.008)	.097			
R^2 b (*p*)	0.125 (0.067)	.064				0.218 (0.092)	.017				0.345 (0.106)	.001			
Model Fit	TRd = 27.52 > χ^2 (4) = 13.28					TRd = 32.55 > χ^2 (5) = 15.09					TRd = 43.79 > χ^2 (5) = 15.09				

Note: Results denote unstandardized parameter estimates. *Est.* = regression coefficient (log odds); p.p. = predicted probability; Threshold = random parameter [P(Y = 1)] for ($x_{i\text{-}k}$ = 0); Ambi = ambiguity; Sem = number of semesters studied; Consci = conscientiousness; Gen. Proc. = general procrastination tendency; T-RV = Threshold Residual Variance; R^2 b = explained variance between; R^2 w = explained variance within; TRd = Chi-Square difference test (α = .01) against the null model, using the Satorra-Bentler test statistic (L. K. Muthén & Muthén, 2020; Satorra & Bentler, 2010). [a] Person-mean centered variable (Level 1; 2286 observations). [b] Grand mean centered variable (Level 2; 88 participants).

exceeding an individual's average perception of task-related ambiguity; *B* = 0.335; *p* = .001; OR = 1.40).[4] The risk that study sessions were procrastinated (vs. not) increased significantly for students whose perceptions of task-related ambiguity exceeded the sample's average (*B* = 0.337; *p* = .044). Students who exceeded the sample's average number of study semesters were significantly less likely to procrastinate studying for their exam. Gender was not significantly related to students' risk for procrastinating study sessions. Model 1 had a significantly better fit compared to the null model (see Table 2).

In Model 2, students' conscientiousness was added as a predictor at Level 2 (results depicted in Table 2). The predicted probability for procrastinating study sessions was 23% (*B* = 1.210; *p* < .001) when all predictors are equal to zero. Study sessions that exceeded an individual's average perception of task-related ambiguity had an increased risk to be procrastinated (*B* = 0.335; *p* = .001; OR = 1.40). The effect of between-person differences in perceptions of ambiguity across study sessions on the risk to procrastinate study sessions was no longer significant when controlling for the influence of between-person differences in conscientiousness. As expected, the risk that study sessions were procrastinated decreased significantly for students' whose conscientiousness exceeded the sample's average (*B* = -0.060; *p* = .006). Again, the risk to procrastinate their study sessions decreased significantly for those students who exceeded the sample's average number of study semesters. Model 2 had a significantly better fit compared to the null model (see Table 2).

In Model 3, students' conscientiousness was substituted using students' trait-level procrastination tendency as a predictor at Level 2 (results depicted in Table 2). Again, the predicted probability for procrastinating a study session was 23% (*B* = 1.196; *p* < .001) when all predictors are equal to zero. The effect of perceptions of ambiguity on the risk that a student procrastinated a study session remained significant. The effect of students' average ambiguity perception across study sessions on the risk to procrastinate study sessions was not significant when controlling for individual differences in procrastination tendency. As expected, the risk that a study session was procrastinated (vs. not) increased significantly for students whose procrastination tendency exceeded the sample's average (*B* = 0.074; *p* < .001). Again, the risk to procrastinate study sessions decreased significantly for those students who exceeded the sample's

average number of study semesters. Model 3 had a significantly better fit compared to the null model (see Table 2).

Table 3 shows the results of the comprehensive model that included all predictors (Model 4). Compared to Model 3, there was no significant increase in model fit for the combined model (see Table 3). The predicted probability for study sessions being procrastinated remained at 23% when all predictors are zero. The risk that students procrastinate a study session increased significantly with their perception of ambiguity (B = 0.337; p = .001; OR = 1.40). Controlling for other trait-level influences, results of Model 4 show that procrastination was not significantly more likely for students who perceived more task-related ambiguity across study sessions. The risk that study sessions were procrastinated increased significantly for students whose procrastination tendency exceeded the sample's average. However, students' conscientiousness was not a significant predictor of their risk for procrastinating study sessions in the comprehensive model (see Table 3). Still, the risk for procrastinating study sessions decreased significantly for students who exceeded the sample's average number of study semesters.

The results of Model 5 (see Table 3) revealed that the average slope[5] for the relationship between perceived ambiguity and session-specific procrastination behavior was statistically significant (B = 0.453; p = .001). Between-person differences in the effect of students' task-related ambiguity perceptions on their procrastination behavior (i.e., the random slope variance) were not significant. However, the model fit improved slightly from Model 4 to Model 5 (see Table 3). Including the random slope and the intercept-slope covariance, the results show a significant effect of students' average ambiguity perceptions on their risk to procrastinate (B = 0.327; p = .039). However, the effect of individuals' ambiguity perceptions on their risk to procrastinate study sessions did not covary significantly with their average procrastination behavior.

Additional analyses were conducted to examine whether individual differences in general procrastination tendency and conscientiousness moderate the effect of students' ambiguity perceptions on their procrastination behavior. The moderating effect of students' conscientiousness on the relationship between students' ambiguity perceptions and their risk to procrastinate study sessions was tested in Model 6 (see Table 4). The moderating

Table 3. *Comprehensive Multi-Level Models Predicting the Risk to Procrastinate (Y = 1) vs. Not to Procrastinate (Y = 0) Intended Study Sessions.*

	Model 4 (Inclusive Model)					**Model 5** (Random Slope Model)				
	Est. (*SE*)	*p*	95% CI		p.p.	*Est.* (*SE*)	*p*	95% CI		p.p.
			LL	*UL*				*LL*	*UL*	
Threshold	1.182 (0.165)	< .001	0.859	1.505	0.23	1.197 (0.167)	< .001	0.870	1.524	0.23
Ambi [a,b]	0.337 (0.103)	.001	0.136	0.538	0.30	0.453 (0.139)	.001	0.181	0.726	0.32
Ambi [c]	0.267 (0.162)	.100	-0.051	0.585	0.29	0.327 (0.158)	.039	-0.017	0.636	0.29
Sem [c]	-0.143 (0.055)	.010	-0.251	-0.035	0.21	-0.128 (0.057)	.025	-0.241	-0.016	0.21
Sex (male)	0.043 (0.377)	.908	-0.695	0.782	0.24	-0.033 (0.372)	.930	-0.763	0.697	0.23
Consci [c]	-0.018 (0.023)	.446	-0.063	0.028	0.23	-0.016 (0.022)	.464	-0.059	0.027	0.23
Gen. Proc. [c]	0.067 (0.016)	< .001	0.035	0.099	0.25	0.062 (0.017)	< .001	0.028	0.096	0.24
T-RV $var(u_{0j})$	1.456 (0.325)	< .001	0.819	2.092		1.527 (0.349)	< .001	0.843	2.210	
Slope $var(u_{1j})$	—					0.309 (0.203)	.129	-0.090	0.707	
Ambi×Proc.B. (u_{01})	—					-0.378 (0.284)	.184	-0.934	0.179	
R^2 w (*p*)	0.013 (.008)	.096								
R^2 b (*p*)	0.350 (.107)	.001				0.330				
Model Fit	TRd = 0.54 < χ^2 (1) = 6.63					TRd = 13.76 ≥ χ^2 (4) = 13.28				

Note: Unstandardized parameter estimates. *Est.* = regression coefficient (log odds); p.p. = predicted probability; Threshold = random parameter [P(Y = 1)] for (x_{i-k} = 0); Ambi = ambiguity; Sem = number of semester studied; Consci = conscientiousness; Gen. Proc. = general procrastination tendency; T-RV = Threshold Residual Variance; Slope = random slope variance; Ambi×Proc. Beh. = ambiguity × procrastination behavior covariance; TRd = Chi-Square difference test (α = .01), based on Satorra-Bentler (L. K. Muthén & Muthén, 2020; Satorra & Bentler, 2010), Model 4 tested against Model 3, Model 5 tested against Model 4. [a] Person-mean centered variable (Level 1; 2286 observations). [b] For Model 5, this is the average random slope effect (u_{1j}). [c] Grand mean centered variable (Level 2; 88 participants). [d] This estimate is not available in Mplus for MLR estimation in logistic multi-level models with random effects, explained level-specific variance for Model 5 calculated according to Hox (2002).

effect of students' general procrastination tendency on the relationship between students' ambiguity perceptions and their risk to procrastinate study sessions was tested in Model 7 (see Table 4). The tested interaction effects were not statistically significant. We find no indication that the effect perceptions of ambiguity had on students' risk for procrastinating study sessions was affected by differences in their conscientiousness or procrastination tendency.

4.5. Discussion

The primary purpose of the present study was to examine the effects that perceptions of task-related ambiguity have on procrastinating intended study sessions during exam preparation while accounting for the influence of individual differences in students' general procrastination tendency and conscientiousness. Conventional questionnaires assessing between-person differences in procrastination tendency and conscientiousness were combined with an adaptive experience sampling approach that captured students' task-related perceptions of ambiguity and their procrastination behavior for different study sessions six times a day during the week before an exam. Overall, the results supported our expectations. Study sessions were significantly more likely to be procrastinated when task-related ambiguity perceptions exceeded the individual's average perception of ambiguity in studying for their exam. However, there was no clear indication that an individual's average ambiguity perception predicted their average risk to procrastinate study sessions. Instead, students' average risk to procrastinate study sessions was related to their general procrastination tendency and conscientiousness. Students with pronounced procrastination tendencies were more likely to procrastinate study sessions. More conscientious students were less likely to procrastinate study sessions. However, students' conscientiousness explained hardly any variance in their procrastination behavior that was not explained by their general procrastination tendency. Moreover, we found no indication for individual differences in the effect that ambiguity perceptions had on the risk to procrastinate study sessions that would be explained by students' general procrastination tendency or conscientiousness.

Table 4. *Person Characteristics Moderating Effects of Ambiguity Perceptions on the Average Risk to Procrastinate Study Sessions.*

	Model 6					Model 7				
	Est. (*SE*)	*p*	95% CI		p.p.	*Est.* (*SE*)	*p*	95% CI		p.p.
			LL	*UL*				*LL*	*UL*	
Threshold	1.217 (0.180)	< .001	0.863	1.570	0.23	1.203 (0.168)	< .001	0.874	1.533	0.23
Ambi Slope [a]	0.511 (0.132)	< .001	0.253	0.769	0.33	0.506 (0.131)	< .001	0.249	0.762	0.33
Ambiguity [b]	0.323 (0.156)	.038	0.017	0.628	0.29	0.340 (0.147)	.021	0.052	0.628	0.30
Semester [b]	-0.128 (0.062)	.039	-0.250	-0.006	0.21	-0.119 (0.057)	.037	-0.230	-0.007	0.21
Sex (male)	-0.060 (0.375)	.874	-0.794	0.675	0.22	-0.035 (0.372)	.925	-0.763	0.694	0.22
Consci [b]	-0.061 (0.022)	.006	-0.105	-0.018	0.22	—	—	—	—	—
Ambi Slope×Consci [c]	-0.016 (0.017)	.339	-0.017	0.050	0.23	—	—	—	—	—
Gen. Proc. [b]	—	—	—	—	—	0.077 (0.016)	< .001	0.045	0.109	0.24
Ambi Slope×Gen.Proc. [c]	—	—	—	—	—	-0.022 (0.013)	.078	-0.047	0.003	0.23
T-RV $var(u_{0j})$	1.928 (0.396)	< .001	1.151	2.705		1.560 (0.358)	< .001	0.858	2.262	
Slope-RV $var(u_{1j})$	0.313 (0.226)	.166	-0.130	0.757		0.289 (0.193)	.134	-0.089	0.667	
Ambi×Proc.Beh. (u_{01})	-0.569 (0.295)	.054	-1.147	0.009		-0.462 (0.262)	.078	-0.976	0.052	
R^2 between [d]	0.153					0.315				
Model Fit	TRd = 14.45 > χ^2 (3) = 11.35					TRd = 17.25 > χ^2 (3) = 11.35				

Note: Results denote unstandardized parameter estimates. *Est.* = regression coefficient (log odds); p.p. = predicted probability; Threshold = random parameter [P(Y = 1)] for ($x_{i\text{-}k}$ = 0); Consci = conscientiousness; Gen. Proc = general procrastination tendency; T-RV = Threshold Residual Variance; Ambi×Proc.Beh = Ambiguity×Procrastination Behavior Covariance; TRd = Chi-Square difference test (α = .01), based on Satorra-Bentler (L. K. Muthén & Muthén, 2020; Satorra & Bentler, 2010), Model 6 tested against Model 2, Model 7 tested against Model 3. [a] Average slope effect (u_{1j}). [b] Grand mean centered (Level 2). [c] Cross-Level Interaction. [d] Estimate not available for MLR estimation in logistic multi-level models with random effects, explained level-specific variance calculated according to Hox (2002).

Essentially, the results of the present study support the assumption that the actual occurrence of procrastination behavior should depend on both persistent trait-level attributes, abilities, or attitudes and more momentary task- or context-specific influences (cf. Sirois & Pychyl, 2013; Tice et al., 2001; van Eerde, 2003). Thus, our findings extend those of previous studies that have typically linked individual differences in students' self-reported procrastination tendency to trait-level indicators that either support or constrain successful self-regulation (see Klingsieck, 2013; Steel, 2007; van Eerde, 2003). Few studies had previously shown that an increased incidence of procrastination behavior was related to daily stresses (such as negative affect, Pollack & Herres, 2020; or poor sleep quality, van Eerde & Venus, 2018). Consistent with these studies, our results suggest that situational influences increased the risk that study sessions were procrastinated. However, the data captured using the adaptive e-diary allowed for a more detailed analysis beyond examining day-level associations. The present results provided evidence for a more situation-specific association between task-related perceptions of ambiguity and the actual occurrence of procrastination behavior. Moreover, the present findings suggest that individual dispositions (i.e., general procrastination tendency or conscientiousness) and situation-specific perceptions of task-related ambiguity (especially about how to proceed) complement each other in their effect on the occurrence of procrastination behavior when studying for an exam.

4.5.1. Within- and Between-Person Variability in Perceptions of Task Ambiguity

To the best of our knowledge, the present study was the first to examine the relationship between the momentary occurrence of procrastination behavior and task-related perceptions of ambiguity in the context of studying for an exam using intensive longitudinal data. Overall, the results revealed considerable variation in students' perceptions of ambiguity at both levels of analysis (i.e., the variance between study sessions and between students). Furthermore, the MCFA results suggest that some students, more than others, perceived their learning tasks as ambiguous in terms of scheduling and performance criteria in general. Most between-person variance was found in students' perceptions of performance criteria ambiguity. In addition, focusing on average ratings (at the student level), perceptions of ambiguity in performance criteria were most

intense compared to the remaining ambiguity items. This finding appears surprising given that most students studied for a multiple-choice exam for which performance criteria could be expected to be relatively well defined.

At the same time, students' momentary perceptions of scheduling and performance criteria ambiguity were less varying between study sessions (i.e., within-person). This seems less surprising for perceptions of scheduling ambiguity because the exam set quite a definite deadline. It appears that most students had some knowledge or plan of when to learn what for their upcoming exam. However, the fact that students' perceptions of scheduling and performance criteria ambiguity did not substantially change between study sessions can also be attributed to the timescale and context of measurements (in the week before an exam). Time-dependent, task- or context-specific fluctuations in perceptions of ambiguity, specifically for scheduling and performance criteria, might be more pronounced in long-term projects (e.g., writing a thesis), with greater task complexity and autonomy of action (e.g., Ackerman & Gross, 2005; Hoppe, Preissler, & Förster, 2018). Further studies with more extensive longitudinal data covering a time frame of several weeks are needed to examine this proposition in more detail.

4.5.2. Task-Related Ambiguity Perceptions Predict Students' Procrastination Behavior

In line with our second hypothesis, results of the multi-level regression analysis revealed that the risk to procrastinate a study session increased when students perceived their task as more ambiguous (compared to their average perception of ambiguity across study sessions). Results on the relationship between students' average perception of ambiguity and their overall risk to procrastinate study sessions were inconsistent. Individual differences in perceptions of ambiguity have not contributed significantly to explain differences in students' procrastination behavior (across study sessions) when accounting for between-person differences in general procrastination tendencies or conscientiousness. However, the effect of average ambiguity perceptions was significant when individual differences in the slopes for the association between ambiguity perceptions and procrastination behavior at the level of study sessions were moderated by individual differences in procrastination tendency or conscientiousness. Thus, it seems justified to

conclude that the average perception of ambiguity in learning tasks varied systematically with students' conscientiousness and general procrastination tendency and explained a common part of the variance in their behavior.

This finding is generally in line with the results of a previous study by Hoppe, Preissler, and Förster (2018). They used a cross-lagged panel design (two measurement points) to show that individual differences in perceptions of ambiguity about writing their thesis predicted students' self-reported procrastination tendency (after several months). However, the event-based design adopted in the present study allowed more direct insights into the relationship between perceptions of ambiguity and students' actual procrastination behavior during exam preparation. Our results show that the risk of procrastinating an intended study session was significantly influenced by students' momentary perception of task-related ambiguity.

Therewith, our findings extend the current understanding of task-related and situation-specific influences that contribute to the occurrence of procrastination behavior. Some studies had previously shown that a negative appraisal of tasks (i.e., tasks being perceived as aversive, effortful, or difficult) was positively related to students' procrastination behavior (Blunt & Pychyl, 2000; Ferrari & Scher, 2000; Pychyl et al., 2000). In addition, the aversiveness toward a task was explained by a lack of perceived control and uncertainty about how to proceed (Blunt & Pychyl, 2000), which seems consistent with our present findings. Most notably, because the effect of ambiguity perceptions on students' procrastination behavior was particularly affected by their uncertainty about suitable learning strategies (i.e., work method ambiguity) in the present study. Successful self-regulation would require resolving ambiguity, revisiting, and possibly adjusting learning strategies (Wolters et al., 2005). Instead, the present results suggest that students follow a helplessness pattern (cf. Pintrich, 2004), as they avoid learning and procrastinate their study session when perceiving a high level of ambiguity (especially uncertainty about how to proceed).

4.5.3. Between-Person Differences Predicting Real-Life Procrastination Behavior

Focusing on the effects of dispositional between-person differences, our results revealed that the risk to procrastinate study sessions was significantly lower for students characterized by an above-average level of

conscientiousness. Moreover, there was a moderately negative correlation between students' conscientiousness and their procrastination tendency. This is generally in line with previous research that has consistently reported negative associations between students' procrastination tendencies and trait-level conscientiousness (DeWitte & Schouwenburg, 2002; Ferrari & Emmons, 1995; Lee et al., 2006; Watson, 2001). Nevertheless, the results of the comprehensive models (Model 4 and Model 5) show that the effect of between-person differences in conscientiousness on students' risk for procrastinating study sessions was outweighed by the effect of between-person differences in their general procrastination tendency. At first sight, this is in line with the notion that procrastination tendencies are an integral part (or lower-order factor) of the more broadly defined conscientiousness trait (Lee et al., 2006; Schouwenburg, 2004; Steel, 2007). However, personality traits are typically defined as relatively perpetual patterns of thoughts, feelings, and behaviors that manifest or express when afforded or encouraged by a situation (e.g., Roberts & Jackson, 2008; Tellegen, 1991). The present study had specifically focused on predicting the actual manifestation of procrastination behavior within real-life academic situations. This is well reflected in the finding that between-person differences in students' general procrastination tendency explained more of the variance in students' procrastination behavior than the more broadly defined conscientiousness trait (34% vs. 22%, controlled for students' average ambiguity perception, gender, and semesters studied).

4.5.4. Recording Real-Life Procrastination Behavior

Our study further contributes to the limited number of studies that have examined relations between students' general procrastination tendencies and their actual procrastination behavior. Indicators of behavioral delay (i.e., delays in task submission or the difference between planned and actual learning time) that have been used in previous studies were weakly or at best moderately related to students' self-reported procrastination tendencies (DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Moon & Illingworth, 2005; Steel et al., 2001). These findings point to some weaknesses in the measures that have been previously used to capture students' procrastination behavior. The temporal discrepancy between the availability of a weekly online test and its actual completion (e.g., Moon & Illingworth, 2005; Steel et al., 2001) has the

disadvantage that later completion does not necessarily reflect procrastination behavior, as it is not known whether students intended to take the test immediately (see Klingsieck, 2013; Krause & Freund, 2014; Wieland et al., 2018). Studies that recorded the weekly or semi-weekly deviation between the time students intended to study and the time they spent studying (e.g., DeWitte & Schouwenburg, 2002; Krause & Freund, 2014) consider that an intention must be present to qualify a deviation as procrastination. However, Krause and Freund (2014) note that this approach ignores other essential criteria for the presence of procrastination behavior. Instead, the adaptive e-diary implemented in the present study accounted for students' current learning intentions and included a measure specifically designed to verify that any indicated delay met additional criteria for procrastination (cf. Klingsieck, 2013; Wieland et al., 2018). Students' actual procrastination behavior was strongly related to their procrastination tendency and conscientiousness, which supports the notion that the approach used in the present study constitutes an appropriate method to capture students' procrastination behavior.

4.5.5. Limitations and Suggestions for Future Research

The present study comes with the strengths of being conducted within a real-life academic setting, using an adaptive experience sampling design, which allowed the assessment of both students' momentary task-related ambiguity perception and procrastination behavior, reaching excellent compliance. Despite these strengths, the study has some limitations that should be noted because they can also inform future research.

At first, the results of our present study may not generalize to other populations. Future studies within non-psychological samples and a more balanced gender ratio and bachelor's vs. master's distribution would be needed. The finding that semesters of study reduced the risk to procrastinate could reflect that more experienced students are more skilled in self-regulated learning. Future studies should control for this possibility.

Second, students in the present sample did not all prepare for the same exam. Different demands and performance criteria may have contributed to more or less intense perceptions of ambiguity. Likewise, individual differences in domain-specific ability (or ability-beliefs) may have contributed to individual differences in ambiguity perceptions and procrastination behavior. We suggest

that future studies focus on students studying for the same exam, controlling for their exam-related ambiguity perceptions and academic self-efficacy beliefs at baseline, and for individual differences in academic performance.

Third, using the e-diary might have encouraged students' self-reflection (Barta et al., 2012; Conner & Reid, 2012). Students may have delayed more study sessions without using the e-diary. However, the observed proportion of 30% procrastinated study sessions in the week before an exam appears rather large to draw this conclusion. Still, future studies might use additional information that is not based on students' self-reports (e.g., behavioral measures of procrastination; DeWitte & Schouwenburg, 2002; Krause & Freund, 2014).

Fourth, the results of the present study are still correlational in nature. Further longitudinal and experimental research will be needed to provide conclusions about the causality in relationships between students' perceptions of task-related ambiguity and their procrastination behavior. This includes studies that use prospective rather than retrospective measures to capture students' intentions and ambiguity perceptions (e.g., Wieland et al., 2018). It would be further useful to consider temporal dependencies in the relationships between ambiguity perceptions and procrastination behavior (including cross-temporal relations). However, to investigate such relationships (e.g., using dynamic structural equation models; Asparouhov et al., 2018; McNeish, 2019), more extensive longitudinal data from a larger number of participants would be needed (Schultzberg & Muthén, 2018), especially in the case of binary outcomes (Schoeneberger, 2015).

4.5.6. Implications

A huge amount of self-help literature deals with the question of how to optimize one's motivation, self-regulation, or time management to avoid procrastination. Most available interventions focus on changing students' behavior using cognitive-behavioral approaches (Schouwenburg et al., 2004; van Eerde & Klingsieck, 2018). Approaches that address more contextual mechanisms of agency and promote self-determined student engagement in learning have been scarce (van Eerde & Klingsieck, 2018).

In line with previous research, our findings reinforce the conclusion that students' procrastination behavior is affected by their task-related experiences and perceptions of situational demands. Therefore, interventions that have a

strong focus on the person but not on the situation might cure the symptoms without changing their causes (cf. Wäschle et al., 2014). Especially in higher education teaching, it will be important to clarify whether interventions should focus on changing the individual through counseling or therapy or changing the situation (study program, curriculum, or task instructions).

While complex tasks are associated with ambiguity (Kagan, 1972; Wood, 1989), they also provide chances for sustainable learning (Wolters et al., 2005). We suggest not to avoid ambiguity but to provide students with the necessary information to self-regulate successfully. That means not to constrain their autonomy (Blunt & Pychyl, 2000; Lay, 1992; Codina et al., 2018), but allow students to participate in goal-setting (Hoppe, Prokop, & Rau, 2018; Pritchard et al., 2008), to set reasonable and transparent performance standards (Ackerman & Gross, 2005), and provide guidelines that reduce ambiguity in scheduling or performance criteria (Ariely & Wertenbroch, 2002; Hoppe, Preissler, & Förster, 2018).

4.5.7. Conclusion

By using an adaptive experience sampling approach, the present study shows that aside from the influence of students' trait-based procrastination tendency, it is their perception of task-related demands that contribute to the occurrence of procrastination behavior in real-life academic contexts. These findings support the view that trait-based dispositions and the perception of task-related demands should be considered complementary in their effect on students' procrastination behavior. Thus, interventions should equally aim to promote students' self-regulatory capacities and revise the information or instruction provided to them.

4.6. Footnotes

[1] Based on the results of a simulation study by Schoeneberger (2015), it was planned to reach a sample size of at least 80 participants to achieve a threshold power of 0.80 for fixed effects with a small sample size (10 to 30 observations) at the within-person level.

[2] Mplus uses a threshold-model concept for logistic regression analyses. Different from an intercept, the threshold value indicates the value (probability expressed in the logit of odds) that must be reached or exceeded to observe the occurrence of an event.

[3] The meaning of being equal to zero depends on the centering procedure applied to the predictor variables. The task-specific ambiguity ratings at Level 1 equal zero for each student's average perception of ambiguity across study-sessions (due to person-mean centering). Predictor variables at Level 2 equal zero at the grand mean (the sample average), except for students' gender (female = 0, male = 1). This principle applies to all models.

[4] Regression coefficients resulting from logistic regression represent the effect of a one-unit increase in the predictor on the log-odds of the outcome in pairwise comparison (i.e., the relative risk for procrastination vs. no procrastination). Odds ratios (OR) > 1 indicate that the risk to procrastinate a session increases when the predictor increases one unit. We also transform the regression coefficients to the predicted probability for study-sessions being procrastinated when the respective predictor increases by one $P(Y = 1 \mid X)$.

[5] Note that the slope refers to the average relationship between students' ambiguity perceptions and their procrastination behavior across study sessions. It is conceived as a latent continuous variable at the between-level. For reasons of comparability, the effect is presented at the same position in Model 4 and Model 5 respectively (see Table 3).

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4.8. Appendix

Appendix A.
Mplus Code used for the Multilevel Confirmatory Factor Analysis (MCFA)

An MCFA was conducted to investigate whether the four items that have been selected from Breaugh and Colihan's (1994) job ambiguity scale to assess students' perceptions of task-specific ambiguity for each learning session could be assigned to one common ambiguity factor both at the level of study sessions (i.e., within-person) and the level of students (i.e., between-person). The following Mplus Code (Version 8.4; L. K. Muthén & Muthén 1998–2017) was used for the analysis:

```
TITLE: MCFA ambiguity items;
DATA:  FILE IS filename.dat;
VARIABLE:
      NAMES ARE code Ambi1 Ambi2 Ambi3 Ambi4 […];
      MISSING ARE all(-99);
      CLUSTER IS code;
      USEVAR = Ambi1 Ambi2 Ambi3 Ambi4;
ANALYSIS: TYPE = TWOLEVEL;
MODEL:
 %WITHIN%
      AMBw BY Ambi1*(WL1)
              Ambi2 (WL2)
              Ambi3 (WL3)
              Ambi4 (WL4);
      AMBw@1; ! Fix Factor Variance to 1

 ! Residual Variances:
      Ambi1 (WR1);
      Ambi2 (WR2);
      Ambi3 (WR3);
      Ambi4 (WR4);

  %BETWEEN%
      AMBb BY Ambi1*(BL1)
              Ambi2 (BL2)
              Ambi3 (BL3)
              Ambi4 (BL4);
      AMBb@1; ! Fix Factor Variance to 1
```

```
 ! Residual Variances:
      Ambi1 (BR1);
      Ambi2 (BR2);
      Ambi3 (BR3);
      Ambi4 (BR4);

OUTPUT: SAMPSTAT STANDARDIZED CINTERVAL;

MODEL CONSTRAINT:
NEW (OMEGAW, OMEGAB);
OMEGAW = ((WL1+WL2+WL3+WL4)**2)/((WR1+WR2+WR3+WR4)
       +(WL1+WL2+WL3+WL4)**2);
OMEGAB = ((BL1+BL2+BL3+BL4)**2)/((BR1+BR2+BR3+BR4)
       +(BL1+BL2+BL3+BL4)**2);
```

Appendix B.
Mplus Code used for the Logistic Multilevel Regression Analysis

Logistic Multi-level Regression Models (LMLMs) were computed to predict the risk for the occurrence of procrastination behavior (Y = 1 study session procrastinated vs. Y = 0 not procrastinated) that was indicated by students preparing for an exam using an e-diary. Predictor variables were added stepwise (Model 1 through Model 7). The following Mplus Code (Version 8.4; L. K. Muthén & Muthén 1998–2017) was used for the analyses (annotations in square brackets):

```
TITLE: Logistic Multilevel Model (LMLM) Proc on Ambi;
DATA: FILE IS filename.dat;
VARIABLE:
   NAMES ARE  code proc AmbiM PMAmbiM NeoC GPS Semester
Sex;
CATEGORICAL = proc;  ! [Y = 1 (proc), Y = 0 (no proc)]
MISSING ARE all(-99);
CLUSTER IS code;
USEVAR = proc
AmbiM ![session-specific ambiguity, average over 4 items]
PMAmbiM ![student-specific average ambiguity]
NeoC ![Conscientiousness Neo-FFI]
GPS ![General Procrastination Tendency, GPS-Score]
Semester ![Number of semesters studied]
Sex ![Gender; 0 = female, 1 = male]
;

WITHIN ARE
AmbiM ;

BETWEEN ARE
PMAmbiM  NeoC  GPS  Semester  Sex; ![Depends on Model]

DEFINE:
CENTER AmbiM (GROUPMEAN); ![Cluster-Mean-Centered]
CENTER PMAmbiM (GRANDMEAN); ![Grand-Mean-Centered]
CENTER NeoC (GRANDMEAN); ![Grand-Mean-Centered]
CENTER GPS (GRANDMEAN); ![Grand-Mean-Centered]
CENTER Semester (GRANDMEAN); ![Grand-Mean-Centered]
```

```
ANALYSIS:
TYPE IS TWOLEVEL; ![Model 1—4; Fixed Slope]
TYPE IS TWOLEVEL RANDOM; ![Model 5—7; Random Slope]

MODEL:
%WITHIN%
 !proc ON AmbiM; ![Model 1—4; Fixed Slope]
 !SLambi | proc ON AmbiM; ![ Model 5—7; Random Slope]

%BETWEEN%
 !proc ON PMAmbiM Semester Sex;   ![Model 1]
 !proc ON PMAmbiM NeoC Semester Sex; ![Model 2]
 !proc ON PMAmbiM GPS Semester Sex; ![Model 3]
 !proc ON PMAmbiM NeoC GPS Semester Sex; ![Model 4]
 !proc ON PMAmbiM NeoC GPS Semester Sex; ![Model 5]
 !proc ON PMAmbiM NeoC Semester Sex; ![Model 6]
 !SLambi ON NeoC; ![Model 6]
 !proc ON PMAmbiM GPS  Semester Sex; ![Model 7]
 !SLambi ON GPS; ![Model 7]
 !SLambi WITH proc; ![Model 5—7; Intercept-Slope
                     Covariance]

OUTPUT: SAMPSTAT STANDARDIZED CINTERVAL;
```

Appendix C.
Detailed Information on the Multilevel Confirmatory Factor Analysis (MCFA) Results

An MCFA was conducted to investigate whether the four items selected from Breaugh and Colihan's (1994) job ambiguity scale to assess students' perceptions of task-specific ambiguity for each learning session could be assigned to one common ambiguity factor at each measurement level (i.e., both at the level of the learning task and the students). Results (see Figure 3) indicated considerable variation in students' perceptions of ambiguity at both levels (i.e., the variance between study sessions and between students). Model fit indices revealed that the specified model fit the data reasonably well. Reliability estimates were satisfactory for both levels of measurement.

The highest loadings (and smallest residual variances) were found for the two indicators representing students' perceptions of work method ambiguity (at both levels). Loadings on the latent factor covering between-person differences in perceptions of ambiguity ranged between $\lambda = .73$ (item 4) and $\lambda = .96$ (item 1). Squared factor loadings represent the proportion of variance in the indicator that is explained by the factor (i.e., its "communality") for the completely standardized solution (Brown, 2015, p. 52). Accordingly, the latent ambiguity factor accounted for 53% (0.73^2 for item 4) to 92% (0.96^2 for item 1) of the between-person variance in the ambiguity indicators.

However, results were less consistent for the within-person level (i.e., for measurements at the level of study sessions). Inspection of ICC's revealed that most within-person variance was observed in students' responses to the two items capturing perceptions of work method ambiguity. Moreover, the loadings of these items to the latent within-person ambiguity factor exceeded that of the items that have been selected to measure scheduling (item 3) and performance criteria ambiguity (item 4). The latent ambiguity factor accounted for 23% (0.48^2 for item 3) to 64% (0.80^2 for item 2) of the within-person variance in the ambiguity indicators. The amount of within-person variance in responses to item 3 (scheduling) and item 4 (performance criteria) accounted for by the latent ambiguity factor was exceeded by their respective residual variances. By deciding to use the item's average as a predictor variable in the subsequent multi-level regression analyses, we have adopted a conservative

approach limiting the potential influence of within-person variability in work method ambiguity perceptions.

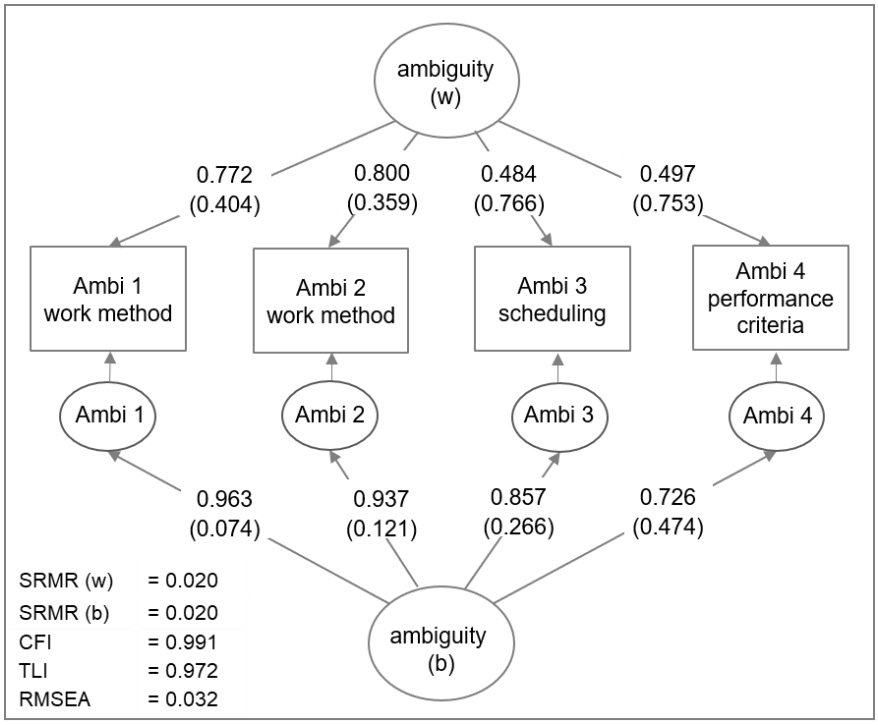

Figure 3. Completely standardized parameter estimates for the one-factor MCFA model covering ambiguity items. The sample consisted of *N*= 88 students; *n* = 2286 measurements, providing an average cluster size of 25.98; Factor variances fixed to 1.0, errors were assumed to be uncorrelated; The model was overidentified (*df* = 4); Paths denote standardized factor loadings (residual variances); All loadings were statistically significant (all $p < .001$).

Chapter 5

5. General Discussion and Future Prospects

5.1. General Discussion

As outlined in the introduction, there are numerous definitions and perspectives on procrastination. Perhaps most promising is the more comprehensive perspective that frames procrastination as a failure in self-regulation (e.g., DeWitte & Lens, 2000; Sirois & Pychyl, 2013; Steel, 2007; Wolters, 2003). At the same time, this perspective requires that research goes beyond the examination of between-person differences in procrastination tendencies to consider that motivational and volitional determinants (as well as emotional experiences) may change depending on the task at hand, and on other situational as well as context-specific influences (e.g., as Dietrich et al., 2017; Pollack & Herres, 2020; Vancouver & Kendall, 2006; van Eerde & Venus, 2018; Wäschle et al., 2014). Accordingly, students' self-regulatory capacities will be affected by the situation, the task, their affective state, and more stable personality traits (as typically presumed in modern self-regulation theories; Boekaerts, 1999; Efklides, 2011; Pintrich, 2004; Winne & Hadwin, 1998). Thus, to consider procrastination as a self-regulatory failure requires the examination of intra-individual changes in behavioral determinants in addition to more traditional trait-based influences. Furthermore, to examine temporal trends in procrastination behavior (e.g., DeWitte & Schouwenburg, 2002; Krause & Freund, 2014; Moon & Illingworth, 2005; Schouwenburg & Gronewoud, 2001) as it occurs in everyday life, valid and reliable measures are required.

The three studies presented in this dissertation addressed these two requirements. First, it was examined whether students' momentary task-specific appraisals would be associated with the occurrence of behavioral delays (Study 1) and procrastination behavior (Study 3), applying an advanced experience sampling approach to capture their self-reported procrastination behavior in real-life academic situations. Second, a measure was provided (Study 2) and applied (Study 3) to adequately distinguish between delays (which can be considered adaptive) and delays that meet the criteria for procrastination. In what follows, the most noteworthy findings of these studies are discussed and related to the state of research to date. The major strengths and some relevant limitations that may be of interest for future research will be identified. Finally, I will suggest potential future fields of application.

5.1.1. Summary and Discussion of Main Findings

Intra-Individual Variation in Behavioral Determinants

The studies presented aimed to predict the occurrence of procrastination behavior in terms of an intention-action gap (Sheeran, 2002; Sheeran & Webb, 2016), or what Svartadal and colleagues (2020) refer to as an "onset delay" – the failure to implement an intended (i.e., goal-directed) action. The design for the ecological momentary assessment of behavioral delays in Study 1 (and in Study 2) was set up with this specific objective in mind. There were two measurements for each task that students planned to address. At first, students planned and scheduled their task (including an initial assessment of their task-specific appraisals – in Study 1), the second measurement (again, involving an assessment about their appraisals – in Study 1) was used to assess the outcome (whether they delayed or implemented their intention to work on the task).

As such, we used a very flexible approach to obtain event-based assessments by taking reference to the participant's intentions (or plan). The participant defines the relevant event in advance, which additionally helps to reduce the participant burden associated with intensive longitudinal assessments (cf. Trull & Ebner-Priemer, 2020; Stone et al., 2003), as high-frequency measurements are not required to capture a rare event of interest. Moreover, the implemented approach provides a highly convenient solution for the problem associated with measuring the absence of an event (not working on a task contrary to the original intention, Svartdal et al., 2018). In this way, it was possible to ensure that students had the intention to work on a task at a certain point in time (in the future), which has not been taken into account in some of the earlier longitudinal studies that have relied on the temporal delays in submissions as indicators for procrastination behavior (e.g., Moon & Illingworth, 2005; Steel et al., 2001).

It may be criticized that the approach that has been applied in the present studies does already constitute an intervention, as the planning phase implicitly involves the formation of an "implementation intention" (Gollwitzer, 1999). However, across all studies included in this dissertation, delays in the implementation of intentions were found in about 20% – 40% of the cases (i.e., tasks planned), which is consistent with other findings from studies that have applied our approach in the meantime (Böhm, 2020; Gadosey et al., 2021). Moreover, the events of delay identified by our approach should be critical cases, as they occur despite an existing intention. Thus, it is very likely that the

results presented for Study 1 and Study 2 (Study 3 used a slightly different design) concern precisely those cases where the intention is insufficient (or not sufficiently temporally stable) to predict the intended behavior (cf. Cooke & Sheeran, 2004; Sheeran, 2002).

Moreover, the findings of Study 1 indicate that the temporal change in students' appraisal of their task (value and aversiveness) had a significant impact on the relative risk for the occurrence of behavioral delays. An increase in the appraisal of the value of the task was associated with a substantial decrease in the risk to delay working on the task. However, an increase in the appraisal of task aversiveness was associated with a marked increase in the risk to delay working on the task. Likewise, the expectation of success (operationalized as the likelihood of working on the task expressed during intention formation) was a robust and significant predictor for the occurrence of behavioral delays. Together, these effects accounted for 30% of the variance in students' behavior (within-person, task-to-task variance).

The value assigned to an outcome and the expectation of being able to achieve that outcome may be the best-studied antecedents of motivation and effort in the performance context and, in principle, reliable predictors of students' behavior (cf., Dietrich et al., 2017; Wigfield & Cambria, 2010; Wigfield & Eccles, 2002). However, the results of Study 1 have highlighted that the subjective appraisal of a given task does not appear to depend on students' ability self-concept or other stable personality traits exclusively, but can vary considerably from task to task and from situation to situation, which is also reflected in the findings presented by Dietrich and colleagues (2017). More importantly, changes in the appraisal of the task (after intention formation) were significant and robust predictors of an individual's behavior (work vs. delay) in Study 1. In addition, the findings revealed that the level of effort required was not associated with the risk to delay working on one's task. This finding highlights that students did not avoid the effort in general. Remarkably, this was not the case because they had only scheduled tasks that required a low level of effort (at least according to the distribution of their self-reported effort ratings). Also, expected effort and aversiveness ratings were rather weakly correlated at the task level (within-level correlation). It was expected that an increase in the effort required – which would reflect that students underestimated the effort required when planning their task (e.g., Duckworth et al., 2011; Oettinen & Gollwitzer,

2010) – would increase the risk that a task will be delayed. This would be a likely explanation for previous findings that unpleasant, stressful, and aversive tasks are more likely to be procrastinated (e.g., Blunt & Pychyl, 2000; Ferrari & Scher, 2000). However, this is not what the results of Study 1 revealed. At the same time, the findings have indicated that task aversiveness raises the risk to delay working on one's tasks. Accordingly, it was even more relevant to investigate other potential reasons for increased task aversiveness levels. Screening previous publications on relations between task aversiveness and procrastination revealed an association with the experience of "uncertainty" (see Ackerman & Gross, 2005; Blunt & Pychyl, 2005; Hoppe et al., 2018).

This relationship was further examined. Study 3 used an adaptive experience sampling approach that captured students' appraisals of task-related ambiguity and their procrastination behavior for different study sessions six times a day for one week before an exam. As expected, the results revealed that uncertainty (ambiguity) about how to proceed when studying for an exam predicted students' procrastination behavior. Most importantly, it was the perception of ambiguity in work methods (i.e., uncertainty or a lack of knowledge about how to proceed) that accounted for within-person variance in perceptions of ambiguity when studying for an exam. This finding suggests that students were more likely to procrastinate intended study sessions when they were uncertain about the actions or the means required to accomplish their task.

It should be noted that the experience sampling design used in Study 3 was not identical to that of Study 1 and Study 2. The adaptive e-diary approach in Study 3 was implemented using different software, which precluded combining two independent measurements. Therefore, students were asked about their intention to study for their exam retrospectively (since the last measurement). Thus, it cannot be ruled out that their retrospective appraisal of ambiguity was a form of excuse – an explanation to "rationalize" their behavior (e.g., Simpson & Pychyl, 2009; Tuckman, 2005). However, this explanation seems unlikely, as this should have also been the case for the other ambiguity indicators (performance criteria and scheduling ambiguity), which were rather weakly associated with work method ambiguity ratings (as reflected in both the within-level correlation and the CFA results for the ambiguity measure – presented in Chapter 4, Appendix C).

In summary, findings on the associations between students' task appraisals and delay behavior (Study 1) or procrastination behavior (Study 3) supported the expectation that momentary task-specific appraisals of task demands – signaling that students' self-regulation was challenged – increased the risk for the occurrence of procrastination behavior. It should be emphasized that between-person differences in task appraisal did not explain variance in individuals' procrastination patterns in Study 1 or Study 3. First, this suggests that individual differences in task appraisal were not of primary relevance for students' procrastination behavior. Second, it highlights the importance of momentary task-specific measurements (in real-time or close to it). Self-regulation is an ongoing process that is highly situation-specific, and the assumption that procrastination is a failure of self-regulation requires the use of appropriate measures to capture the micro-level mechanisms involved (see also, Molenaar, 2004; Schmitz, 2006). In addition, the findings from Study 1 and Study 3 are informative as they show that unfavorable task appraisals are a risk factor that could be prevented by creating more optimal conditions for students' self-regulated learning, thus preventing procrastination in their everyday behavior (e.g., Ariely & Wertenbroch, 2002; Hoppe et al., 2018; Wild, 2000).

Between-Person Differences in Procrastination

Turning to between-person findings, Study 1 revealed that trait measures of procrastination tendency (TPS and APSI) were not significantly related to the delay behavior that students had reported using the e-diary. This finding was consistent with previous studies (e.g., Krause & Freund, 2014; Moon & Illingworth, 2005). Moon and Illingworth (2005) have concluded that trait measures may be inappropriate to predict students' procrastination behavior. However, another consideration of relevance would be the appropriateness of the measure used to capture students' procrastination behavior. This concern was addressed in Study 2. While the requirement that an intention must be present for any delay to be classified as procrastination was readily addressed by design in Study 1, Klingsieck (2013) derived additional criteria for defining procrastination from her review of the literature. Krause and Freund (2014) have further stressed that cognitive-affective aspects are relevant to consider behavioral delays as procrastination behavior, which is not reflected in observed indicators of behavioral delays. Therefore, the e-MAPS developed in Study 2 was constructed to cover both aspects (the situation and the cognitive-affective

component). The results of an Exploratory Factor Analysis supported this concept. However, it should be noted that we performed a between-person analysis (EFA based on the tetrachoric correlation matrix). At the time of data analysis, no software package was available that had implemented a suitable solution for an adequate two-level analysis of the factor structure with binary indicators.

Moreover, the results of Study 2 revealed that students' procrastination tendencies assessed via TPS and APSI were associated with the patterns in students' procrastination behavior identified by the e-MAPS, which warrants the interpretation that the e-MAPS was an appropriate measure of procrastination behavior. This conclusion was further supported in Study 3, in which between-person differences in procrastination tendencies assessed by the GPS were found to predict students' procrastination patterns. While individual differences in conscientiousness have also predicted students' procrastination behavior, this effect vanished when controlling for differences in procrastination tendencies (note that the NEO-FFI conscientiousness scale contains items closely related to procrastination).

Meanwhile, findings from other studies have provided further support for the validity of measurements obtained by the e-MAPS (Böhm, 2020 unpublished master's thesis; Gadosey et al., 2021). Most importantly, the experience sampling study conducted by Gadosey and colleagues (2021) examined students' procrastination behavior during exam preparation and revealed that procrastination behavior (as indicated by the e-MAPS), but not behavioral delay, was predicted by individual differences in procrastination tendencies (assessed using the TPS). In addition, momentary experiences of exam-related anxiety were significantly related to the relative risk that students' procrastinated learning for their exam (Gadosey et al., 2021). Together, these findings clearly show that the e-MAPS is a valuable and valid tool to capture students' procrastination behavior in academic settings.

In summary, the approach developed to examine students' procrastination behavior in the studies presented within this dissertation has the potential to contribute significantly to extend the existing knowledge about what determines the occurrence of procrastination behavior. Additionally, the results of the presented studies indicate that it is very problematic to use the term *delay* or *dilatory behavior* as a synonym for *procrastination behavior*. Confusion about

the exact meaning of these terms may be partially due to linguistic differences, but I would like to argue for a more precise distinction in the context of research on the underlying construct.

5.1.2. Limitations and Suggestions for Future Research

While the studies presented to examine students' procrastination behavior have several strengths, they also come with limitations that remain to be addressed. In the following, I will name the most important limitations and provide some recommendations for future research.

The subjective experience of a given situation needs to be consciously reflected before it can be reported. Self-report measures require conscious recall, which can alter the outcome of the measured experiences and the behavior (e.g., Barta et al., 2012; Conner & Reid, 2012). This problem is inherently related to the use of self-report measures. However, the students themselves may be the best, if not the only, source to provide information about their subjective experience of study tasks (cf. Crombach et al., 2003; Stone, 2000). Moreover, students were never asked directly about "procrastination" when they reported their procrastination behavior using the e-diary in the present studies. Thus, procrastination behavior was captured as indirectly as possible. Also, the number of reported procrastination events was not so small that we would have to conclude they were heavily affected by the procedure. Compared to indirect measures of delay behavior that have been used in previous studies (e.g., temporal delays in submitting homework, or the ratio of time intended to time spent studying), the advantages of the self-report approach that has been presented in this dissertation outweigh the disadvantages.

Further evidence for the criterion validity of the events captured by the e-MAPS will be required. Future studies should preferably also assess (objective) performance criteria (e.g., actual exam performance) or psycho-physiological indicators to capture students' stress levels (e.g., Koudela-Hamila et al., 2020). Likewise, there is preliminary evidence that self-reported sleep quality can be a suitable indicator for a limited ability to self-regulate (e.g., Baumeister et al., 2017), which has been found to be related to both procrastination tendencies and actual procrastination behavior (e.g., Kroese et al., 2014; van Eerde & Venus, 2018). Given that previous findings related procrastination tendencies to

impulsivity, more objective measures of impulsivity could be used as a suitable criterion (e.g., the Stroop-Task; Stroop (1935), or the Stop-Signal paradigm; Logan & Cowan (1984); Verbruggen & Logan (2009)).

A further limitation of the present research is that students' self-regulatory ability was only inferred indirectly based on the data collected in Study 1 and Study 3. A suitable measure to capture individual differences in self-regulatory ability, self-control beliefs, or ability self-concept was not included in these studies. Possibly, intra-individual variability in the appraisal of the tasks was more pronounced for those students with less favorable expressions on these traits. Future research should include appropriate measures to investigate potential interaction and moderation effects.

Capturing procrastination behavior requires careful consideration of several temporal parameters when setting up the sampling strategy. While Study 1 and Study 2 were thoroughly planned to include the phases relevant in the course of action (intention formation and the intended initiation of an action), this approach has not been consistently applied in Study 3. Instead, the temporal distance to the exam was a relevant parameter taken into account in Study 3 but not in Study 1 or Study 2. All of the studies come with the major limitation that the students were working on a variety of different tasks and were preparing for different exams. As a result, some confounding variables may not have been considered in our analyses. Particularly in Study 3, it would have been desirable to control for individual differences in exam performance. However, the exams were so diverse that there was no way to include the type of exam as a categorical control variable. Accordingly, exam performance would also have been unlikely informative.

Future studies should consider both the proximal subjective norm of the intention and the distal external frame of reference of the performance goal to be achieved. Studies including students working toward the same "normed" performance goal (e.g., passing a specific exam) while simultaneously setting their individual learning goals would be more informative in many ways. First, this would eliminate some of the confounding variables, and second, it would allow for the examination of temporal trends in procrastination behavior that have not been addressed in the research presented in this dissertation.

The statistical methods applied to analyze the data provided by the studies require some additional considerations. Data obtained by experience sampling

have at least a two-level structure. In this case, the measurements are nested in persons. It would be equally possible to assume a three-level structure, with the day-level included, which would have two advantages. First, day-level variation in associations could be more adequately accounted for in the analysis. Second, it would account for the fact that tasks could be postponed across several days. Accordingly, multiple measurements for the same tasks have entered the analyses. We have not accounted for this fact (a) because the proportion of these multiple measurements was so small that it could not have been adequately represented in a three-level structure, and (b) because we did not perform a multilevel analysis on the data provided by Study 2 for the reasons outlined below. However, future studies covering longer sampling periods could provide valuable insights into the temporal development of procrastination behavior if multiple measurements were available for the same task and were adequately analyzed.

It should also be mentioned that the analysis of binary outcome variables (Study 1 and Study 3) or indicators (Study 2) poses particular challenges. As noted above, when the data of Study 2 were analyzed, there was no option to account for the underlying two-level structure in the analyses. The e-MAPS items have a binary response format. The criterion is present, or it is not present. It is not a dimensional measure, so it would be more appropriate to apply a probabilistic measurement model. Unfortunately, Mplus has only recently implemented options to allow for this kind of analysis (Asparouhov & Muthen, 2020), and there was no other software solution that would have allowed this type of analysis (at least to the best of my knowledge).

Another aspect to consider as a consequence of the binary outcome measure (procrastination is present vs. procrastination is not present) is the sample size required to achieve sufficient statistical power (e.g., Schoeneberger, 2015). It is not reasonable to suggest that the sample size (at Level 1) was sufficiently large to provide reliable estimates of any cross-level relations either in Study 1 or in Study 3. Considering the added value of such analyses mentioned above, an attempt to replicate the findings presented in studies with larger samples that additionally account for relevant cross-level interactions would be desirable. It would also be preferable to obtain a larger number of within-person measurements (at Level 2). This would be particularly relevant to consider temporal trends and perform cross-lagged analyses that can indicate the

direction of the indicated relationships (e.g., using dynamic structural equation models; Asparouhov et al., 2018; McNeish, 2019). Specifically, analyzing temporal trends would require that all students work toward the same goal over an extended time.

Moreover, when the studies were planned, we had no information on how frequently the event of interest (i.e., procrastination behavior) might occur on average over time (e.g., over one week). Based on the information provided by the present studies (and on the figures reported by Böhm, 2000; Gadosey et al., 2021), we can conservatively estimate that procrastination behavior will be reported in 10% to 30% of the measurements. Thus, procrastination is a relatively "rare event" (cf. Schoeneberger, 2015), which in turn requires a large number of measurements to achieve the sample size necessary for complex analyses (i.e., involving cross-level interactions or cross-lagged analyses). I venture a recommendation to plan for a sample size of at least 100 individuals and 4000 measurements to reach the thresholds suggested by Schoeneberger (2015).

Finally, it must be mentioned that the findings reported in the present studies cannot be interpreted as causal relationships. In Study 1, a bidirectional relationship between the appraisal of the task and the occurrence of the procrastination behavior is quite unlikely due to the study design (i.e., the procedure of data collection applied), but it cannot be ruled out. In Study 3, it is quite possible that the occurrence of the procrastination behavior affected the appraisal of the situation (i.e., that students tried to find an excuse for their behavior and therefore rated the task to be ambiguous). However, especially discussing the results of Study 3 (Chapter 4), it was argued that tasks and instructions (or the information provided to the students) could affect students' experience of control and, accordingly, their procrastination behavior (for a similar line of reasoning, see Krause & Freund, 2016). However, attempts would have to be made to experimentally (or quasi-experimentally) manipulate the conditions assumed to be influential. To date, there have been limited efforts in this direction (but refer to the following examples: Froese et al., 1984; McCrea et al., 2008; Senécal et al., 1997; Tifferet, 2020). Moreover, future research should involve randomized controlled trials under standardized conditions in the field (e.g., Loeffler et al., 2019), where instructional aspects could be manipulated.

5.1.3. Conclusion and Future Prospects

Considering the findings presented in this dissertation, it will be apparent that a more comprehensive understanding of procrastination will not be reached as long as the different perspectives (person vs. task-level) will not be combined (see also Klingsieck, 2013; van Eerde, 2003). More importantly, insight into the dynamic processes that affect procrastination behavior under everyday conditions is only possible when situational and especially task-specific influences are taken into account – in addition to person-level determinants. Some seminal research has pursued this direction in the past two decades (e.g., Moon & Illingworth, 2005; Pollack & Herres, 2020; Pychyl et al., 2000; van Eerde & Venus, 2018; Steel et al., 2018).

What the approach developed in the three studies presented in this dissertation adds is (1) the important insight that not every delay can be considered procrastination, something that should be reflected in future studies; (2) The frame of reference used to interpret delays as procrastination needs to be reflected in the study design. The approach presented in Study 1 and Study 2 highlights the strength of the idea to use the individual's intention as the frame of reference. The strength of this approach is that, based on the experience sampling design (used in Studies 1 and 2), it can be determined whether the intention was implemented at the intended time; (3) In addition, a practical tool has been provided that can be used to clarify the temporal relationships between states assumed to be influential (e.g., appraisals, emotions, sleep quality, energy level) and procrastination. Although this was beyond the scope of this dissertation, I would like to suggest that future studies take advantage of this research approach to more thoroughly test the mood-repair hypothesis put forth by Sirois & Pychyl (2013). A first attempt is already available with the work of Gadosey and colleagues (2021), but the results presented by Pollack and Herres (2020) on the relationship between experiences of positive or negative affective states and the occurrence of procrastination behavior could have been even more informative if they had not analyzed their data aggregated at the day level. The approach presented here would be excellently suitable to investigate these questions further.

In addition, there are some implications for practice that I would like to mention. The approach developed to assess the individual's behavior and identify motivationally critical situations may not be limited to research on

procrastination. There are various fields of research and practice in which the occurrence of intention-behavior gaps is relevant, especially in health-related behaviors such as dietary behaviors (e.g., Inauen et al., 2016), the domain of physical activity and exercise (e.g., Kaftan & Freund, 2019; Rhodes & de Bruijn, 2013), but also in the domain of clinical health (e.g., Scholz et al., 2007). In all of these areas, the benefits of experience sampling methods have been recognized and used successfully. The development of tailored interventions that can be delivered via the smartphone into the individual's everyday life is of special interest (cf. Reichert et al., 2018; Reichert et al., 2020; Schlicht et al., 2013). One key factor in implementing effective interventions in real life is tailoring both the momentary measurements and the feedback to the individual's needs (e.g., Aryana et al., 2019; Carpenter et al., 2016; Trull & Ebner-Priemer, 2013). The possibility of integrating individuals' intentions into the sampling design is a promising innovation relevant for a wide field of research and application. Retrospective queries about events "since the last moment of measurement" could be circumvented. The person could be reminded of the intention and asked about the outcomes of interest. Overall, this would enable a substantial flexibilization in the survey design and facilitate more personalized feedback.

While numerous published interventions focus on treating students with pronounced procrastination tendencies (cf. Schouwenburg et al., 2004; van Eerde & Klingsieck, 2018), prevention approaches have been rarely addressed. Given that students' procrastination behavior is affected by their appraisal of the task at hand – and the resources presently available to them – it would be reasonable to consider whether the given conditions (i.e., tasks and instructions) can be adapted to support their capacity for self-regulation. Applicable strategies could include setting reasonable and transparent performance standards (cf. Ackerman & Gross, 2005), providing guidelines that reduce ambiguity in scheduling or performance criteria (cf. Ariely & Wertenbroch, 2002; Wild, 2000), and that students are allowed to participate in goal setting (cf. Pritchard et al., 2008).

5.2. References

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Eidesstattliche Versicherung

Eidesstattliche Versicherung gemäß § 13 Absatz 2 Satz 2 Ziffer 3 der Promotionsordnung des Karlsruher Instituts für Technologie (KIT) für die KIT-Fakultät für Geistes- und Sozialwissenschaften:

1. Bei der eingereichten Dissertation zu dem Thema

> Predicting Procrastination in Everyday Life: From Individual Differences in Procrastination Tendencies to Intraindividual Variability in Momentary Task Appraisal

handelt es sich um meine eigenständig erbrachte Leistung.

2. Ich habe nur die angegebenen Quellen und Hilfsmittel benutzt und mich keiner unzulässigen Hilfe Dritter bedient. Insbesondere habe ich wörtlich oder sinngemäß aus anderen Werken übernommene Inhalte als solche kenntlich gemacht.

3. Die Arbeit oder Teile davon habe ich bislang nicht an einer Hochschule des In- oder Auslands als Bestandteil einer Prüfungs- oder Qualifikationsleistung vorgelegt.

4. Die Richtigkeit der vorstehenden Erklärungen bestätige ich.

5. Die Bedeutung der eidesstattlichen Versicherung und die strafrechtlichen Folgen einer unrichtigen oder unvollständigen eidesstattlichen Versicherung sind mir bekannt.

Ich versichere an Eides statt, dass ich nach bestem Wissen die reine Wahrheit erklärt und nichts verschwiegen habe.

Ort und Datum: Karlsruhe, 20.05.2021

Unterschrift: _____