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From procrastination to frustration—How delaying tasks can affect study satisfaction and dropout intentions over the course of university studies

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ABSTRACT

Procrastination leads to obstructive consequences for students in higher education. Cross-sectional studies show that procrastination is positively associated with study dissatisfaction and students' intentions to drop out of their university degree program. However, the reciprocal effects between these variables throughout an entire university degree program are still equivocal. Drawing on a sample of $N = 463$ students enrolled in university teacher education and applying cross-lagged panel modelling, this is the first longitudinal study that provides evidence that procrastination leads to dissatisfaction while dissatisfaction leads to dropout intentions over the course of three years of studying, rather than the other way around. Our findings support the relevance for universities to implement effective intervention programs to help students reduce procrastination, improve their well-being, and decrease their intentions to drop out of their university degree program.

Educational relevance statement: The most detrimental effects on higher education students' achievement-related behavior and well-being are due to their maladaptive learning strategies indicated by procrastination. The main goal of the present research was gaining deeper insights into the reciprocal relations between students' procrastination, study satisfaction, and dropout intentions in higher education. It should be noted that the reciprocal effects between these variables throughout an entire university degree program are still equivocal. In this study, we examined individual differences in the longitudinal and possibly reciprocal associations between procrastination, study satisfaction, and dropout intentions over the course of three years of university education. This is the first longitudinal investigation that provides evidence for the hypotheses suggesting that procrastination leads to dissatisfaction while dissatisfaction leads to dropout intentions over time, rather than the other way around. Our findings have practical implications for implementing prevention and intervention programs at universities that can assist students in decreasing procrastination, improving their well-being, and reducing their intentions to drop out of their university degree program.

1. Introduction

Research provides evidence that one of the most detrimental effects on university students' achievement-related behavior (Schneider & Preckel, 2017), emotional states (Rahimi et al., 2023) and well-being (Grunschel et al., 2016; Pychyl & Sirois, 2016) are due to their maladaptive learning strategies indicated by procrastination—a voluntarily delay of an intended course of action despite expecting to be worse off for the delay (Steel, 2007). Following Schouwenburg (2004) the prevalence rate for students' procrastination in academic settings is up to 70 % (Ellis & Knaus, 1979), whereas 50 % procrastinate consistently, accounting for more than one third of their daily activities (cf. Klingsieck, 2013). Procrastinators tend to fail in maintaining goal-directed behavior that might foster their perception of not making progress in reaching (learning) goals (e.g., Wieber & Gollwitzer, 2010), which in turn might increase their dissatisfaction (e.g., Lent, 2005) and their intentions to drop out from their university degree program (Tinto, 1975). While some authors assume that procrastination causes these obstructive effects on the outcomes (e.g., Schraw et al., 2007), other researchers argue that low study satisfaction and high dropout intentions may undermine students' achievement motivation and therefore increase their likelihood for procrastination (Scheunemann et al., 2022). Taken

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together, possible reciprocal effects between procrastination, study satisfaction, and dropout intentions over the course of an entire university degree program are still equivocal, and longitudinal studies investigating the temporal reciprocal effects between those variables over the course of university studies are rare (Scheunemann et al., 2022). It should be noted that Scheunemann et al. (2022) were the first to investigate the temporal reciprocal effects between students' academic procrastination, study satisfaction, and dropout intentions over the course of one semester. However, their findings are ambiguous, leading them to suggest that the time interval for investigating the interrelations between all three variables is not long enough to reveal the reciprocal associations. The authors also question the robustness of their results and recommend that future studies should draw on a larger sample size and control for additional third variables, such as gender, grade point average (GPA), and different semesters. Furthermore, it cannot be ruled out that the cross-lagged panel model used by Scheunemann et al. (2022) might have suffered from unobserved confounding, resulting in biased estimates (cf. Lüdtke & Robitzsch, 2022).

Therefore, the present study seeks to build upon Scheunemann et al.'s (2022) study. By addressing its limitations, our study aims to provide robust insights into the longitudinal reciprocal relations between procrastination, study satisfaction, and dropout intentions over the course of an entire university degree program. While Scheunemann et al. (2022) investigated academic procrastination, which pertains to the delay of academic tasks such as writing papers and preparing for exams, our study explores more general procrastination tendencies among students. This includes the deferral of intended tasks in everyday life, such as work tasks but also university assignments (Rahimi et al., 2023). Despite the minor differences between both constructs, we expect similar results for procrastination, given that students' general procrastination and academic procrastination are closely intertwined constructs (for details see e.g., Rahimi et al., 2023; Şirin, 2011). However, in the following text, the term ‘procrastination’ refers specifically to students' general procrastination, particularly in the academic context.

Owing to the three-year interval of investigation in our study, our findings may significantly contribute to procrastination research by addressing the question of whether students' general procrastination is a cause or consequence of dissatisfaction and dropout intentions over time.

Furthermore, our results may enable the implementation of prevention and intervention programs helping university students to reduce procrastination (van Eerde & Klingsieck, 2018) while improving their self-regulated learning strategies and study satisfaction (Wolters, 2003) as well as reducing their intentions to drop out from their university degree program over the course of time (Bäulke et al., 2022; Heublein, 2014; Schneider & Preckel, 2017).

1.1. Procrastination among university students: cause or consequence of dissatisfaction and dropout intentions?

Following Steel (2007), procrastination inherently has no adaptive functionality for human behavior since it goes in line with several individual negative long-term consequences such as poor well-being and low performances in achievement situations. Procrastination is considered a relatively stable trait characterized as “weakness of the will” in terms of the voluntarily delay of an intended course of action despite expecting to be worse off for the delay (cf. Steel, 2007, p.81). Therefore, procrastination is assumed to be distinct from strategic delays of action and seems to play a major role for students' maladaptive behavior in higher education (e.g., cf. Schneider & Preckel, 2017). It is assumed that men are more prone for procrastination compared with women, while individual levels of procrastination seem to decrease when people become older because they use more sophisticated self-control strategies to overcome dysfunctional behavior (e.g., Steel, 2007; Steel & Ferrari, 2013). Other studies provide evidence that high levels of procrastination are associated with lower GPA and a longer time of studying (Scheunemann et al., 2022; Steel, 2007).

Comparing a variety of constructs that foster or hinder students' achievement-related behavior and well-being in higher education, procrastination seems to be the candidate related to the most obstructive consequences for students (Schneider & Preckel, 2017; Steel, 2007). Various cross-sectional studies provide evidence that procrastination is positively associated with study dissatisfaction (e.g., Balkis & Duru, 2016; Fritzsche et al., 2003; Grunschel et al., 2016) and students' intentions to dropout from their university degree program (e.g., Bäulke et al., 2022). These correlational findings do not provide sufficient evidence to make statements about the direction of effects or potential reciprocal effects between these variables (Scheunemann et al., 2022), given the limited availability of longitudinal studies investigating these relationships. Gaining deeper insights into the longitudinal interrelations between procrastination, study satisfaction, and dropout intentions might be of interest especially for individuals, researchers, and university institutions (cf. Scheunemann et al., 2022), since dissatisfied students with dysfunctional study habits seem to have stronger tendencies to drop out from their university degree programs and are prone to drop out more frequently (Bean & Metzner, 1985; Tinto, 1975). On the one hand, if procrastination leads to lower study satisfaction, higher dropout intentions and dropout rates, researchers need to develop more adequate procrastination prevention programs helping students to improve their self-regulated learning strategies. On the other hand, if study dissatisfaction and students' tendencies to drop out from their university degree program foster students' procrastination, university institutions should introduce sophisticated organizational developmental programs to improve study conditions (e.g., Carstensen et al., 2021; Lindner & Klusmann, 2018; Zimmermann et al., 2018) and thereby enhance their well-being (e.g., study satisfaction) as well as their goal directed study behavior (i.e., less procrastination).

Study satisfaction represents the cognitive component of students' subjective well-being (Diener et al., 2018) characterizing their individual attitudes toward studying (Westermann et al., 1996). According to the temporal motivation theory (Steel, 2007; Steel & König, 2006), being dissatisfied regarding one's own university degree program might negatively impact individuals' expectancies and values concerning studying and, therefore, might lead to higher tendencies for procrastination. In line with Carver and Scheier (2005), negative affective states such as dissatisfaction might reinforce procrastination, hindering individuals to initiate activities that reduce the discrepancy between their current state (e.g., starting to learn for an examination) and their desired goal (e.g., having learned all course material) when studying (Carver & Scheier, 1982).

Arguing the other way around, perceiving oneself as not making progress in reaching own (achievement) goals due to procrastination might increase students' probability to become dissatisfied (Bean & Metzner, 1985; Lent & Brown, 2008). This assumption aligns with the process model of self-control failure (Inzlicht et al., 2014), which proposes that a key psychological mechanism linked to interruptions in goal-directed behavior is the shift from positive to negative emotional states, making procrastination a likely predictor of dissatisfaction with studying.

Following Tinto (1975), study dissatisfaction hinders students from academic integration, undermining their commitment for reaching intended study goals (e.g., performing well; completing studies successfully), and consequently, this might foster their intentions to drop out from their university degree program. A variety of studies provide evidence for the negative relations between study satisfaction and students' dropout intentions (e.g., Fleischer et al., 2019; Freeman et al., 2007; Mashburn, 2000; Starr et al., 1972).

Students' intentions to dropout might depend on individuals' external factors such as poor study conditions and some internal components such as personality traits, low study motivation, poor academic performance, and dysfunctional study behavior (e.g., Bernholt et al., 2023; Heublein, 2014; Lindner & Klusmann, 2018). Cross-sectional studies

found positive relations between students' dropout intentions and procrastination (Bäulke et al., 2018, 2022). High tendencies to procrastinate might hinder students to reduce the discrepancy between their current state (e.g., studying in the first semester at the university) and their desired state (e.g., finishing studying and earning a Bachelor degree), due to poor self-control strategies (Carver & Scheier, 1982, 2005). Consequently, students realizing that the probability to finish studying is low might increase their dropout intentions over the course of studying.

Moreover, Scheunemann et al. (2022) refer to Ghassemi et al. (2017) who mention that students' dropout intentions indicate increasing doubt about the goal of obtaining a university degree or represent high discrepancies between expectations concerning the study subject and personal interests (e.g., Lindner & Klusmann, 2018). Suhlmann et al. (2018) show that the fit between personal characteristics and the attributes and expectations of the learning environment at university (i.e., Person-Environment fit effect) predicts students' feeling of belonging to the university, which in turn is predictive for their dropout intentions. These findings imply that a misfit between students' personal characteristics and the characteristics of the studied subject or the learning environment at the university might lead to students' withdrawal cognition (i.e., inner resignation) and dropout intentions (Mashburn, 2000). As a plausible consequence, dropout intentions might cause changes in students' learning behavior, thereby fostering their voluntarily delay of an intended course of action, which is the core aspect of procrastination.

Taken together, theoretical considerations and cross-sectional studies point out that procrastination, study satisfaction, and dropout intentions are substantially related among university students. However, longitudinal studies examining the reciprocal causal relationship between those variables are still rare. Therefore, the present study aims to investigate the longitudinal and potentially reciprocal interplay between procrastination, study satisfaction, and dropout intentions over the course of studying. Specifically, we seek to gain deeper insights into the question of whether students' procrastination is cause or consequence of dissatisfaction and dropout intentions in higher education.

1.2. First longitudinal findings on reciprocal relations between academic procrastination, study satisfaction, and study dropout intentions in higher education provided by Scheunemann et al. (2022)

In their study, Scheunemann et al. (2022) explored the longitudinal reciprocal relations between academic procrastination, study satisfaction, and dropout intentions of students enrolled in mathematics and law over the course of one semester, applying cross-lagged panel modelling (CLPM). A high temporal stability was found for all three variables across time (see also Eckert et al., 2016; Ng & Ye, 2016; Perez et al., 2014). Scheunemann et al. (2022) found moderate to high correlations within each wave, providing evidence that procrastination is positively related to dropout intentions and negatively associated to study satisfaction, whereas dropout intentions and study satisfaction correlated negatively (see also e.g., Balkis & Duru, 2016; Bäulke et al., 2018, 2022; Mashburn, 2000). Focusing on the cross-lagged effects, procrastination did not predict subsequent study satisfaction or dropout intentions at any measurement point. As expected, dropout intentions measured in the middle of the semester (second measurement point) were positively related to subsequent procrastination at the end of the semester. Unexpectedly, a higher level of study satisfaction measured at the second measurement point led to a higher level of procrastination at the subsequent measurement point. According to this contradictive result, Scheunemann et al. (2022) speculate that satisfied students may feel more confident and may feel they have to invest less study time to achieve good results in their university studies, resulting in higher levels of procrastination.

The results of Scheunemann et al. (2022) provide important first insights into the longitudinal reciprocal relationships between students' procrastination, study satisfaction, and dropout intentions in higher education. Nevertheless, the authors name some limitations of their study that we try to address in the present research. Scheunemann et al. (2022) discussed that the time interval for investigating the interrelations between all three variables was only over the course of one semester, perhaps not enough time to reveal stable effects of the reciprocal associations between the investigated variables over the short time course. Furthermore, they also question the robustness of their CLPM results and suggest that further studies should draw on a larger sample size and control for third variables (e.g., gender, GPA, different semesters). Not discussed by Scheunemann et al. (2022), the traditional CLPM might suffer from unobserved confounding, since the model is based on a selection-on-observables approach and provides biased estimates if not all relevant covariates are measured (cf. Lüdtke & Robitzsch, 2022).

1.3. The present research

The first aim of the present study was to build on the study of Scheunemann et al. (2022) which explore individual differences in the longitudinal reciprocal interrelations between students' procrastination, study satisfaction, and dropout intentions. In procrastination research, there is still an unanswered question of whether students' procrastination is a cause or consequence of dissatisfaction and dropout intentions in higher education, because various cross-sectional studies relying on correlative findings do not allow for definite statements about causal relations between those variables (see e.g., Balkis & Duru, 2016; Bäulke et al., 2022; Fritzsche et al., 2003; Grunschel et al., 2016). The present study is the first to investigate the directions of interrelations between students' general procrastination, study satisfaction, and dropout intentions over the course of three years in higher education, while controlling for multiple potential confounders. Scheunemann et al. (2022) found high temporal stability for academic procrastination, study satisfaction, and dropout intentions across one semester. Since general procrastination and academic procrastination are closely related constructs (for details see e.g., Rahimi et al., 2023; Şirin, 2011), we expected the highest temporal stabilities over the course of three years of studying for procrastination, which is assumed to be a stable personality trait (Steel, 2007). In contrast to the findings of Scheunemann et al. (2022), we assumed less temporal stabilities for study satisfaction and dropout intentions, because these variables also depend on study conditions at the university (e.g., Lindner & Klusmann, 2018). Such conditions may vary more significantly over a three-year period as opposed to the one-semester time frame investigated by Scheunemann et al. (2022). Scheunemann et al. (2022) argued that the cross-lagged effects between academic procrastination, study satisfaction, and dropout intentions would reveal a more complex interplay among the variables that needs to be explored in greater detail. Therefore, the present study aimed to explore whether students with higher levels of procrastination than others are more or less likely to experience subsequent (i.e., one and two years later) lower levels in study satisfaction and higher levels in dropout intentions. Likewise, students with lower levels of study satisfaction or higher levels of dropout intentions than others may be more or less likely to experience increases in procrastination after one and two years of studying. To investigate these assumptions and answer the research questions, we applied an equivalent CLPM as applied by Scheunemann et al. (2022).

Regarding the second aim of the current study, we adopted a causal perspective for investigating directed interrelations between procrastination, study satisfaction, and dropout intentions over the time course. Since the traditional CLPM might suffer from manifold confounding (cf. Lüdtke & Robitzsch, 2022), we controlled for several covariates in our

model that have been found to be related to procrastination, study satisfaction, and dropout intentions, including age, gender, migration background, GPA, number of studied STEM subjects, and study time (e.g., Mishra & Müller, 2022; Pawson, 2012; Scheunemann et al., 2022). In contrast to Scheunemann et al. (2022), in our study we additionally specified a "full-forward"[1] cross-lagged panel model (FF-CLPM; cf. Guay et al., 2003; Hübner et al., 2023) by adding lag-2 effects (Little, 2013). This approach allowed us to account for unobserved confounding and gain a better understanding of the causal relationships between these variables (Lüdtke & Robitzsch, 2022). Consequently, our final research question focused on the robustness of the CLPM results in the light of the results from the more valid FF-CLPM.

2. Methods

2.1. Procedure and participants

The sample of the present research stems from the first three waves (T1 – T3) of the *'Student Teacher Professional Development Study (STePS)'* and comprised $N = 463$ students enrolled in teacher education at Kiel University in Germany (Carstensen et al., 2019; Lindner, Klusmann, et al., 2018a, 2018b). Launched in 2017 (i.e., T1), STePS is an ongoing panel study with a yearly online assessment (in January) on prospective teachers' development. For each measurement occasion, all prospective teachers at the university were invited to participate in the study via email. As shown in Fig. 1, the overall sample by wave 3 included $N = 3185$ prospective teachers which corresponds to an average response rate of 31 % of all potential eligible prospective teachers at this university over all waves (see also Carstensen & Klusmann, 2021).

For investigating reciprocal effects between procrastination, study satisfaction, and dropout intentions, we selected $N = 463$ bachelor of education students who were potentially enrolled in the identical main subjects in all three waves and who were assessed at least twice. The analysis of sample selectivity showed only marginal differences between the analysis sample and filtered participants (i.e., $N = 2722$ participants not included in the analysis sample). As detailed in Table S1 in the online supplement, the analysis sample included younger students ($p < .001$, $d = 3.712$), slightly more female participants ($p = .013$, $d = 0.089$), students with a slightly better GPA ($p = .002$, $d = 0.524$) and higher levels in study satisfaction ($p = .004$, $d = 0.621$) compared to the filtered participants. No statistically significant differences were found between the analysis sample and the filtered sample concerning procrastination ($p = .470$) and dropout intentions ($p = .281$).

At T1, of the $N = 463$ participants, 69.3 % were female, 13.4 % had a migration background and 43.6 % studied at least one STEM subject. Furthermore, the mean age of all participants was $M_{age} = 21.97$ ($SD = 2.81$), their final secondary-school grade point average (GPA) was $M_{GPA} = 2.24$ ($SD = 0.50$), and they studied their subjects on average for $M_{study\text{-}time} = 2.34$ ($SD = 1.45$) years at Kiel University. More precisely, at T1, 38.0 % of the participants were students studying in the 1st semester, 21.6 % in the 3rd semester, 22.2 % in the 5th semester, and 18.1 % in higher semesters. Of all participants, $n = 171$ (36.9 %) students participated three times (T1 – T3) and $n = 292$ (63.1 %) participated two times (T1 and T2 or T1 and T3).

This study was carried out in accordance with the Declaration of Helsinki and the ethical guidelines for research with human participants as proposed by the German Psychological Society (DGPs) and the American Psychological Association (APA). Prior to data collection, the protocol of the present panel study was discussed at and ethically approved by the research colloquium of the Leibniz Institute for Science and Mathematics Education. Furthermore, the corporate legal counsel of Kiel University approved the study. Informed consent was obtained from all participants.

2.2. Instruments

2.2.1. Procrastination

Students' procrastination was measured using the German 9-items version (e.g. "I keep saying: "I'll do that tomorrow.""; Klingsieck & Fries, 2012) of the General Procrastination Scale (Lay, 1986). The items were rated on a 5-point Likert scale ranging from 1 *'very untypical for me'* to 5 *'very typical for me'*. The scale's internal consistency was excellent at all three measurement points ($\alpha_{T1} = 0.93$, $\alpha_{T2} = 0.92$, $\alpha_{T3} = 0.93$).

2.2.2. Study satisfaction

Students' satisfaction with their university degree program was measured with a scale taken from a well-established German instrument (3 items, e.g., "Overall, I'm satisfied with my current studies."; Westermann et al., 1996). The items were rated on a 4-point Likert scale ranging from 1 *'not correct at all'* to 4 *'absolutely correct'*. The scale's reliability was good at all three measurement points ($\alpha_{T1} = 0.82$, $\alpha_{T2} = 0.86$, $\alpha_{T3} = 0.84$).

2.2.3. Dropout intentions

Dropout intentions from the university degree program was measured with an adapted scale from Ditton (1998) (3 items, e.g., "I have often thought about dropping out of the university teacher training program."). All items were rated on a 4-point Likert scale, anchored at 1 *'not correct at all'* and 4 *'absolutely correct'*. The scale's reliability was acceptable or good at all three measurement points ($\alpha_{T1} = 0.76$, $\alpha_{T2} = 0.78$, $\alpha_{T3} = 0.79$).

2.3. Data analysis

In a first step, we investigated missingness and possible violations of the missing completely at random assumption by comparing the groups of students that participated three times (T1 – T3) vs. two times (T1 and T2 or T1 and T3), using two-sample *t*-tests for continuous variables and Chi-squared tests for categorical variable. Significant group differences in any variable would indicate correlations between the corresponding variable and missingness (i.e. missing at random assumption; Baraldi & Enders, 2010).

Second, we studied the reciprocal effects of procrastination, study satisfaction, and dropout intentions. In line with Scheunemann et al. (2022), we specified a latent cross-lagged panel model (CLPM) with autocorrelated error variables (e.g., Geiser, 2013), using structural equation modelling (SEM) in Mplus 8.6 (Muthén & Muthén, 2017). In this model we also controlled for the manifest time-invariant covariates age, gender, migration background, GPA, number of studied STEM subjects, study-time, and additionally, the frequency of participation in the present study (two- vs. three-times). Controlling for these confounders was necessary since previous research found relations between procrastination, study satisfaction, dropout intentions, and the covariates (e.g., Mishra & Müller, 2022; Pawson, 2012; Scheunemann et al., 2022). Furthermore, adding these covariates in our model improves the estimation of missing values, using the full information maximum likelihood estimator (FIML; e.g., Baraldi & Enders, 2010). The FIML approach is an appropriate method to manage missing data in longitudinal studies resulting in trustworthy, unbiased estimates for missing values (Graham, 2009).

In the next step, we specified an FF-CLPM (cf. Guay et al., 2003; Hübner et al., 2023), by adding lag-2 effects (Little, 2013) to our CLPM, while all other specifications remained equal to the CLPM. Taking a causal perspective, including lag-2 effects in CLPM provides a more comprehensive control for confounding, since the traditional CLPM is

[1] The term 'full-forward' was first introduced by Marsh et al. (1999) to describe a type of multiwave-multivariable cross-lagged panel model. In the graphical representation of the model (see Fig. 2B), every latent variable is connected to all subsequent latent variables by single-headed arrows, representing 'causal' effects.

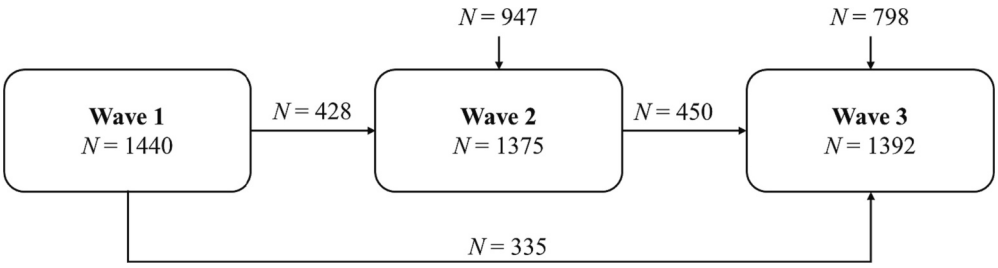

Fig. 1. Design of the Student Teacher Professional Development Study (STePS). The initial sample consisted of $N = 1440$ prospective teachers. Each subsequent wave consisted of student teachers from the preceding waves as well as participants who had newly joined the panel study (e.g., first-year students). A total of $N = 3185$ prospective teachers took part in the study. Participants in the analysis sample ($N = 463$) attended at least twice and served as a basis for the longitudinal analyses (see also Carstensen & Klusmann, 2021).

based on a selection-on-observables approach and provides biased estimates if not all relevant covariates are measured (cf. Lüdtke & Robitzsch, 2022). VanderWeele (2021, p. 607)[2] illustrates advantages specifying lag-2 effects in CLPM for investigating temporal interrelations between two variables (e.g., X and Y) measured three times longitudinally (see also Lüdtke & Robitzsch, 2022). Therefore, the FF-CLPM allows for a more rigor exploration of causality regarding the temporal interrelations between procrastination, study satisfaction, and dropout intentions over the course of studying. In both models, we allowed correlated uniqueness. That is, we allowed correlations between the residuals of the items used to specify the latent variables procrastination, study satisfaction, and dropout intentions that were measured on several occasions for the same subjects. As mentioned by Möller et al. (2011), ignoring these correlated uniquenesses typically results in positively biased stability coefficients (e.g., Marsh & Hau, 1996).

The goodness-of-fit was assessed by means of the Chi-square statistic (χ^2), the Tucker–Lewis Index (TLI), the Comparative Fit Index (CFI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR). As the Chi-square statistic is known to be highly sensitive to sample size and to small deviations from a perfect fit, we followed the recommendations of Marsh et al. (2004) and Browne and Cudeck (1993), who noted that the TLI and CFI should be 0.90 or greater, whereas the RMSEA should generally be 0.08 or smaller. SRMR values should be below 0.08.

Finally, before estimating the CLPM and FF-CLPM (see Fig. 2), we tested for measurement invariance over time for procrastination, study satisfaction and dropout intentions including the above-mentioned covariates to see whether the meanings of the constructs of the latent factors were the same at every measurement occasion. We conducted confirmatory factor analyses (CFA), where each covariate and all latent variables on each time of measurement were intercorrelated (Little et al., 2007). Using the effects-coding method for identifying the latent factors, we fixed the average of all factor loadings to the value 1.0 and the average of all indicator intercepts to the value 0 (Little et al., 2006). The measurement invariance across time was tested by comparing four nested models with each other. These models implement configural (no invariance of parameters), weak (factor loadings), strong (factor loadings + item intercepts), and strict invariance (factor loadings + item intercepts + item residual variances) over time. If at least weak invariance is present, measures can be compared across measurement occasions (Little et al., 2007). To decide on the presence of invariance, benchmarks for model comparison are required. This comparison can be performed by means of a χ^2-difference test, which, however, is subject to the same problems as the χ^2-test. Accordingly, guidelines for comparison of other fit statistics (e.g., CFI, RMSEA) have been established. For testing intercept or residual invariance, changes in CFI ≥ -0.010 that are supplemented by a change of ≥ 0.015 in RMSEA or a change of ≥ 0.010 in SRMR indicate the absence of invariance (Chen, 2007; Cheung & Rensvold, 2002). In addition, fit-indices of TLI and RMSEA favor parsimonious over less parsimonious models (e.g., Marsh, 2007).

Testing invariance over time, the model assuming configural invariance fitted the data well, χ^2 (1116) = 1766.41, CFI = 0.944, TLI = 0.933, RMSEA = 0.035 and SRMR = 0.043. The model fit for the weak invariance model was χ^2 (1140) = 1792.35, CFI = 0.944, TLI = 0.934, RMSEA = 0.035 and SRMR = 0.044. Finally, we tested strong, χ^2 (1164) = 1834.32, CFI = 0.942, TLI = 0.934, RMSEA = 0.035 and SRMR = 0.044, as well as strict invariance χ^2 (1194) = 1871.68, CFI = 0.941, TLI = 0.935, RMSEA = 0.035 and SRMR = 0.045. Regarding the guidelines for model comparisons, the assumption of strict measurement invariance across time was supported (ΔCFI = 0.003; ΔRMSEA = 0.000; ΔSRMR = 0.002).

3. Results

3.1. Panel attrition

To investigate differences between teacher-students who participated three vs. two times, two-sample *t*-tests for procrastination, study satisfaction, dropout intentions, age, GPA, and study time as well as chi-square-tests for gender, migration background and number of studied STEM-subjects were conducted, using data measured at T1 (see Table 1). Between both groups, no significant differences were found for age, migration background, GPA, number of studied STEM subjects, study time, study satisfaction, and dropout intentions. However, the groups differed significantly between gender $\chi^2(1) = 3.890$, $p = .049$, $d = 0.184$ and procrastination $t(461) = 3.238$, $p = .001$, $d = 0.312$, therefore we decided to include the variable 'number of participation' (two times = 0; three times = 1) as an additional covariate in our CLPM and FF-CLPM (see below).

3.2. Descriptive statistics

As presented in Table 2, the latent bivariate correlations between procrastination, study satisfaction, dropout intentions (measured at T1, T2 and T3) and the sociodemographic variables (measured at T1) were small to high ($p \leq .05$). Regardless of the time of measurement, procrastination was positively related to dropout intentions, gender (1 = male), and GPA (higher values indicate worse performance), and negatively related to study satisfaction. Furthermore, procrastination was positively correlated with age (T2) and migration background (T2) as well as negatively with the number of studied STEM-subjects (T1) and

[2] VanderWeele (2021) argues that if the initial exposure X_{t-2} affects the subsequent exposure X_{t-1}, and also independently, affects the outcome Y_t not through X_{t-1}, then prior exposure itself confounds the cross-lagged of X_{t-1} on Y_t. Therefore, prior values of the exposure and outcome measures (X_{t-2} and Y_{t-2}) can be considered as additional covariates in the CLPM, reducing further confounding. In addition, controlling for initial levels of interrelated variables in longitudinal studies helps to rule out reverse causation (VanderWeele et al., 2016).

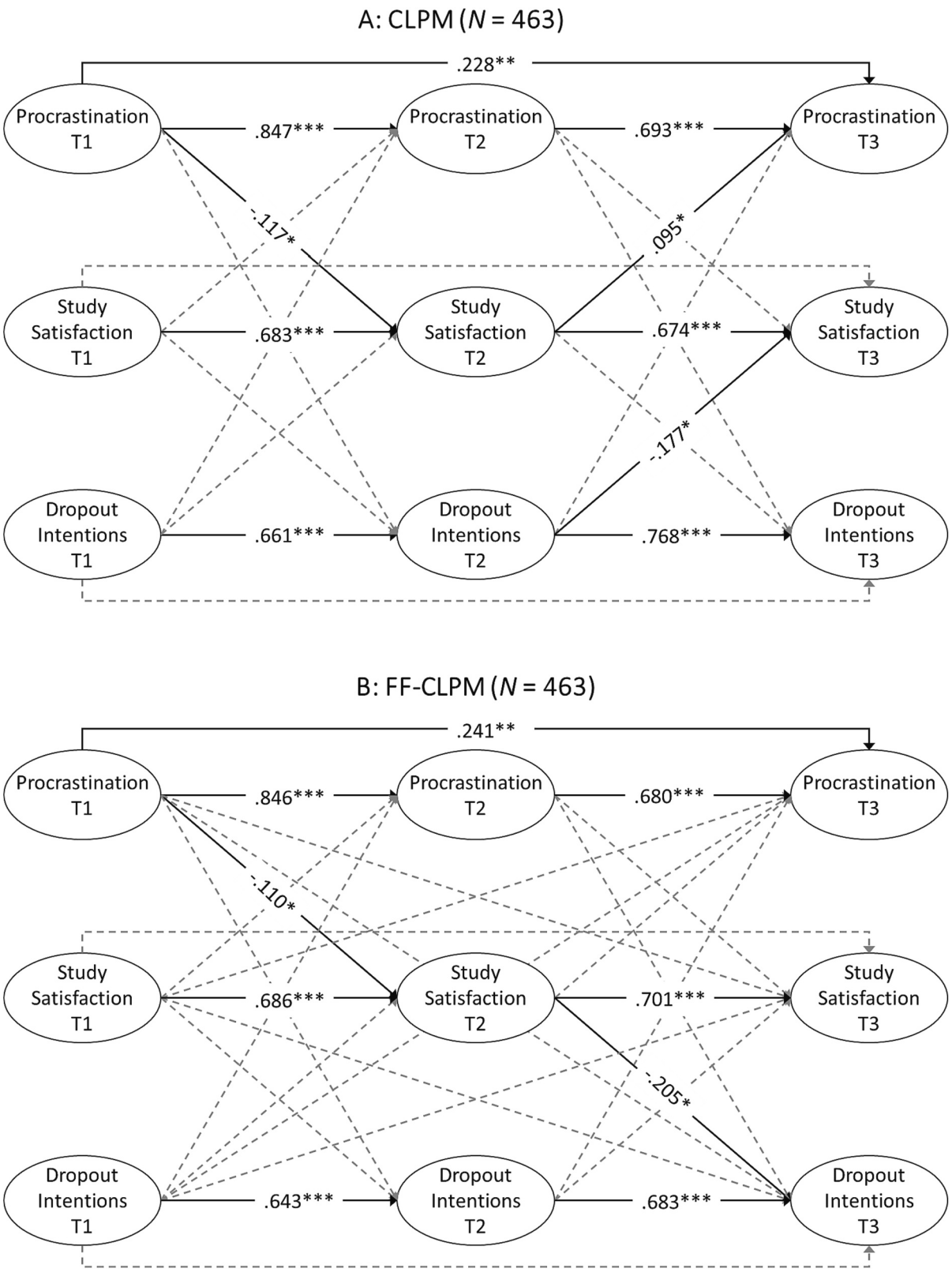

Fig. 2. Standardized coefficients of (A) the cross-lagged panel model and (B) the full forward cross-lagged panel model including lag-2 effects, both with strict measurement invariance across three years of studying for procrastination, study satisfaction and dropout intentions controlling for age, gender, migration background, GPA, number of studied STEM subjects, study time and frequency of study-participation. *Note.* T1 – T3: measurement points 1–3 (i.e., 2017, 2018, and 2019). Dotted lines indicate non-significant paths and correlations. $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$. Covariates, correlated uniqueness, (residual) correlations between the variables within all measurement occasions, and residual variances were omitted to improve readability.

Table 1
Sample characteristics and differences between groups of students participating two vs. three times.

		Participated three times	Participated two times				
Variables	*Category*	*M (SD); F_n (%); (n = 171)*	*M (SD); F_n (%); (n = 292)*	*t*(461)	χ^2(1)	*p*	*Cohen's d*
Age	Years	21.74 (2.39) [23–67]	22.11 (3.02) [19–79]	1.345	–	0.179	0.130
Gender	Male	43 (25.1 %)	99 (33.9 %)	–	3.890	0.049	0.184
	Female	128 (74.9 %)	193 (66.1 %)	–			
Migration background	Yes	21 (12.3 %)	41 (14.0 %)	–	0.288	0.591	0.050
	No	150 (87.7 %)	251 (86.0 %)	–			
GPA	Abitur	2.23 (0.55)	2.24 (0.47)	0.262†	–	0.794	0.026
STEM subjects	None	97 (56.7 %)	164 (56.2 %)	–	0.014	0.907	0.011
	One or two	74 (43.3 %)	128 (43.8 %)	–			
Study time	Years	2.22 (1.34)	2.41 (1.52)	1.413††	–	0.159	0.132
Procrastination		2.74 (0.86)	3.01 (0.89)	3.238		0.001	0.312
Study satisfaction		3.20 (0.59)	3.17 (0.53)	−0.680		0.497	−0.065
Dropout intentions		1.44 (0.53)	1.52 (0.56)	1.378		0.169	0.133

Note: †df = 313.620 and ††df = 393.188, due to unequal variances.

the frequency of participation (T1 and T2) in the present study (two times = 0; three times = 1). Negative associations were found between study satisfaction and dropout intentions (T1 – T3). Years of studying was negatively related to study satisfaction (T2) as well as positively related to dropout intentions (T1 and T2). Finally, negative correlations were found between GPA and study satisfaction (T2), and positive associations were found for gender and dropout intentions at T3. Further significant intercorrelations between the sociodemographic variables are shown in Table 2.

3.3. Results of the latent cross-lag panel model (CLPM)

The CLPM was used to evaluate the structural relations of the repeatedly measured constructs procrastination, study satisfaction, and dropout intentions, while controlling for the time-invariant covariates. The CLPM assuming strict invariance fitted the data well; χ^2 (1200) = 1882.50, CFI = 0.939, TLI = 0.934, RMSEA = 0.035 and SRMR = 0.046. The autoregressive effects represent the stability of individual differences from one measurement occasion to the following. These are the effects of our three constructs on themselves, whereas the cross-lagged effects are the effects of each construct on each other construct measured at a later occasion, controlling for the prior level of the corresponding construct being predicted.

Fig. 2A displays the standardized effects of the CLPM with strict measurement invariance for procrastination, study satisfaction and dropout intentions. In the model, direct effects of all covariates on procrastination, study satisfaction and dropout intentions were specified for every measurement occasion (T1 – T3).

All first-order autoregressive effects of the corresponding variables were significant and strong ($0.661 \leq \beta \leq 0.847$, all $p < .000$) but varied across the constructs. The second-order autoregressive effect of procrastination was significant ($\beta = 0.228$, $p = .006$), whereas no significant second-order autoregressive effects of study satisfaction and dropout intentions were found. The results support our assumption since highest temporal stability was found for procrastination, followed by study satisfaction, and dropout intentions.

A significant negative cross-lagged effect was found for procrastination at T1 on study satisfaction at T2 ($\beta = -0.117$, $p = .022$). Furthermore, study satisfaction at T2 predicted procrastination at T3 ($\beta = 0.095$, $p = .038$), and dropout intentions at T2 negatively affected study satisfaction at T3 ($\beta = -0.177$, $p = .013$). None of the other cross-lagged effects in the CLPM were significant. As Orth et al. (2022) suggest, standardized cross-lagged effects of 0.03 represent small effects, 0.07 medium effects, and 0.12 large effects. According to these benchmarks, the cross-lagged effects in our CLPM can be interpreted as medium and high.

3.4. Results of the full-forward latent cross-lag panel model (FF-CLPM)

The FF-CLPM is an extended version of the CLPM for testing more complex lead-lag relations between our repeatedly measured constructs. More precisely, each of the constructs has paths leading to all other constructs in all subsequent measurement occasions.

Standardized effects of the FF-CLPM, including strict measurement invariance and direct effects of all covariates on procrastination, study satisfaction and dropout intentions (T1 – T3) are presented in Fig. 2B. The FF-CLPM assuming strict invariance fitted the data well; χ^2 (1194) = 1876.85, CFI = 0.939, TLI = 0.934, RMSEA = 0.035, SRMR = 0.046.

In line with the results of the CLPM, first-order autoregressive effects of procrastination, study satisfaction, and dropout intentions were also strong in the FF-CLPM ($0.643 \leq \beta \leq 0.846$, $0.000 \leq p \leq .006$). The second-order autoregressive effect of procrastination was also significant in the FF-CLPM ($\beta = 0.241$, $p = .006$).

None of the lag-2 effects were significant, but the negative cross-lagged effect of procrastination at T1 on study satisfaction at T2 ($\beta = -0.110$, $p = .034$) remained stable across both models (CLPM and FF-CLPM). Furthermore, in the FF-CLPM study satisfaction at T2 negatively predicted dropout intentions at T3 ($\beta = -0.205$, $p = .030$).[3] Compared to the CLPM, the effects of study satisfaction at T2 on procrastination at T3 and dropout intentions at T2 on study satisfaction at T3 were not significant in the FF-CLPM. Applying the benchmarks of Orth et al. (2022), both significant cross-lagged effects in our FF-CLPM can be interpreted as strong. Detailed results of the FF-CLPM are presented in Table S2 in the online supplement.

3.5. Post-hoc power analysis for detecting significant effects in the FF-CLPM

To evaluate the statistical power of detecting the autoregressive effects and the cross-lagged effects of procrastination (T1) on study satisfaction (T2) and study satisfaction (T2) on dropout intentions (T3) in the FF-CLPM, we conducted post-hoc power analyses using Monte Carlo simulation studies as implemented in Mplus 8.6 (Muthén & Muthén, 2017). To this end, we used the parameter estimates from our real FF-CLPM data analyses as population values. The sample size was set at $N = 463$. To ensure that the results of our simulation studies were stable (Muthén & Muthén, 2017), we chose 10,000 replications with a seed of 5000 for the random draws from the population. The statistical

[3] The total indirect effect (95 % CI = [−0.045, 0.404]), as well as the specific indirect effect of procrastination at T1 on dropout intentions at T3 via study satisfaction at T2 (95% CI = [−0.002, 0.067]) were not significant.

Table 2
Estimated bivariate correlations between all variables of investigation.

$N = 463$	*M* /%	*SD*	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
(01) Procrastination T1	2.91	0.89	-														
(02) Procrastination T2	2.84	0.86	**0.87**	-													
(03) Procrastination T3	2.76	0.93	**0.83**	**0.91**	-												
(04) Study satisfaction T1	3.18	0.55	**−0.27**	**−0.25**	**−0.11**	-											
(05) Study satisfaction T2	3.15	0.60	**−0.30**	**−0.26**	**−0.15**	**0.69**	-										
(06) Study satisfaction T3	3.14	0.58	**−0.22**	**−0.20**	**−0.20**	**0.49**	**0.74**	-									
(07) Dropout intentions T1	1.42	0.55	**0.23**	**0.18**	**0.17**	**−0.56**	**−0.28**	**−0.33**	-								
(08) Dropout intentions T2	1.39	0.57	**0.20**	**0.16**	**0.19**	**−0.36**	**−0.43**	**−0.47**	**0.69**	-							
(09) Dropout intentions T3	1.40	0.60	**0.17**	**0.16**	**0.23**	**−0.19**	**−0.37**	**−0.51**	**0.46**	**0.78**	-						
(10) Age	21.97	2.81	0.01	**0.12**	0.00	0.02	−0.06	−0.08	0.04	−0.02	−0.08	-					
(11) Gender (1 = male)	30.7 %	–	**0.20**	**0.19**	**0.21**	−0.03	−0.01	−0.01	0.10	−0.02	**0.25**	**0.12**	-				
(12) Migration background (1 = yes)	13.4 %	–	0.10	**0.18**	0.13	−0.06	−0.04	−0.04	−0.05	−0.10	0.00	0.02	0.02	-			
(13) GPA (1 = best, to 6 = worst)	2.24	0.50	**0.14**	**0.19**	**0.19**	−0.07	**−0.18**	−0.07	−0.06	−0.01	−0.04	**0.17**	0.03	**0.18**	-		
(14) STEM subject (1 = one or two)	43.6 %	–	**−0.15**	−0.09	−0.05	−0.04	−0.04	−0.12	0.01	−0.01	0.09	0.00	**0.12**	−0.01	**−0.26**	-	
(15) Years of studying	2.34	1.45	0.06	0.08	0.05	−0.07	**−0.14**	−0.02	**0.18**	**0.09**	−0.11	**0.59**	0.09	0.05	**0.15**	−0.06	-
(16) Participation (1 = three times)	36.9 %	–	**−0.19**	**−0.21**	−0.09	0.04	−0.01	−0.08	−0.10	−0.10	0.04	−0.09	**−0.15**	−0.05	−0.02	0.00	−0.08

Note: T1 – T3 = Measurement occasions 1 to 3; Statistically significant correlations are given in bold. $p < .05$; Variables 10–15, measured at T1.

power of our analyses is indicated by the proportion of replications for which the null hypothesis that a parameter equals zero was rejected ($p < .05$). The parameters for the autoregressive effects, and the cross-lagged effects of procrastination (T1) on study satisfaction (T2) as well as study satisfaction (T2) on dropout intentions (T3), revealed a statistical power ranging between 67.5 % and 100 %. These results underline the basic power of the FF-CLPM in our study to detect the autoregressive effects, and the cross-lagged effects. Detailed results of the post-hoc power analysis are presented in the online supplement.

4. Discussion

The most detrimental effects on higher education students' achievement-related behavior and well-being are due to their maladaptive learning strategies indicated by procrastination (e.g., Grunschel et al., 2016; Schneider & Preckel, 2017). Therefore, the main goal of the present research was gaining deeper insights into the reciprocal relations between students' procrastination, study satisfaction, and dropout intentions in higher education using a longitudinal design. Our research builds upon the work of Scheunemann et al. (2022), a study of significant value that has contributed to our initial understanding of the longitudinal interrelations between students' procrastination, study satisfaction, and dropout intentions. We have taken into account the limitations acknowledged by the authors and have expanded upon their research in several keyways. Compared to Scheunemann et al. (2022) who investigated $N = 326$ mathematics and law students over the course of a single semester, our study encompasses a broader and more diverse sample of $N = 463$ students enrolled in teacher education. These students represent a wide range of main subjects, both STEM and non-STEM, and we have examined the interplay between procrastination, study satisfaction, and dropout intentions over an extended period of three years of studying. Furthermore, Scheunemann et al. (2022) expressed reservations about the robustness of their CLPM results and suggest that future studies should control for additional third variables. Therefore, in our CLPM we controlled for several covariates (e.g., gender, GPA, different semesters), and in addition to the CLPM, we specified a FF-CLPM that allows a more rigorous test of causality regarding the temporal interrelations between procrastination, study satisfaction, and dropout intentions over the course of studying.

In our study, strict measurement invariance across time was supported for procrastination, study satisfaction and dropout intentions. Regardless of the time of measurement, the latent bivariate correlations between procrastination, study satisfaction, dropout intentions were small to high, and procrastination was positively related to dropout intentions, as well as negatively related to study satisfaction. While our findings span a period of three years, they exhibit a correlation pattern akin to the results of Scheunemann et al. (2022) over a single semester. This consistency underscores the robustness of these relationships across different time scales.

The model fit statistics of the FF-CLPM were good and identical to the model fit of the CLPM. Against this background, we prefer the more trustworthy results of the FF-CLPM because the additional lag-2 effects allow for a stronger causal interpretation by offering a more comprehensive control for confounding, resulting in less biased estimates and ruling out reverse causation between procrastination, study satisfaction, and dropout intentions (VanderWeele et al., 2016).

The CLPM and the FF-CLPM both revealed significant and strong negative cross-lagged effects of procrastination at T1 on study satisfaction at T2 beyond the autoregressive effect on study satisfaction at T1. This finding is in accordance with the social cognitive career theory (Lent & Brown, 2008), postulating that not making progress in goal attainment might lead to dissatisfaction due to self-control failure and individual shifts from positive to negative affective states (Balkis & Duru, 2016; Inzlicht et al., 2014). In line with cross-sectional findings and theoretical assumptions (Balkis & Duru, 2016; Grunschel et al., 2016), our study provides evidence for longitudinal effects of

procrastination on study satisfaction across one year of studying. Same as in the study of Scheunemann et al. (2022), longitudinally, procrastination did not predict dropout intentions beyond the autoregressive effects at any measurement occasion.

Focusing on the cross-lagged effects at T2 on T3, the results for the CLPM differed from the FF-CLPM findings. As previously shown by Scheunemann et al. (2022), our CLPM also revealed a positive cross-lagged effect of study satisfaction at T2 on procrastination at T3. Adding lag-2 effects in the FF-CLPM allows to control for unobserved confounders (Lüdtke & Robitzsch, 2022; Marsh et al., 2022). The cross-lagged effect of study satisfaction at T2 on procrastination at T3 was not significant in the FF-CLPM, since the lag-2 effects considered delayed effects that are not captured by the lag-1 effects. The same appeared on the negative cross-lagged effect of dropout intentions at T2 on study satisfaction at T3, which was significant in the CLPM but not significant in the FF-CLPM. In contrast to the CLPM, the FF-CLPM revealed a strong negative cross-lagged effect of study satisfaction at T2 on dropout intentions at T3, which is in line with previous longitudinal findings (e.g., Fleischer et al., 2019) and theoretical assumptions in dropout models (Tinto, 1975). For example Tinto (1975) speculates that low study satisfaction might hinder students from academic integration, undermining their commitment for reaching intended study goals and, as a consequence, might foster their dropout intentions.

Our FF-CLPM revealed no significant effects of study satisfaction and dropout intentions on procrastination. These results allow deeper insights concerning the open research question on the longitudinal causal relationships between the investigated variables. Our study is the first that provides evidence for the implicit assumptions made in various cross-sectional studies (for an overview see Scheunemann et al., 2022) that procrastination causes low study satisfaction but not vice versa. It appears that dysfunctional study behavior resulting in a lack of progress toward one's academic goals can lead individuals to shift from positive to negative affective states while studying (Inzlicht et al., 2014), which increases the likelihood of experiencing dissatisfaction (Bean & Metzner, 1985; Lent & Brown, 2008). Interestingly, procrastination was not found to be significantly associated with subsequent dropout intentions, a finding that aligns with the results of Scheunemann et al. (2022) and contradicts the theoretical assumptions of both, dropout models (Bean & Metzner, 1985) and procrastination theory (Bäulke et al., 2018).

Focusing on the autoregressive effects in the CLPM and the FF-CLPM, compared with temporal stabilities of study satisfaction and dropout intentions, strongest first-order autoregressive effects and a significant second-order autoregressive effect were found for procrastination. These results support our assumption about the strongest temporal stabilities for procrastination, which is associated with conscientiousness, a rather stable personality trait (Steel, 2007). Compared with the findings of Scheunemann et al. (2022) who investigated interrelations of the three variables over the course of one study semester, our three-year longitudinal study revealed stronger first-order autoregressive effects of study satisfaction, comparable large autoregressive effects of procrastination, and slightly weaker autoregressive effects of dropout intentions (at least in the FF-CLPM).

Taken together, following the more trustworthy main results of our FF-CLPM, the negative effect of procrastination on study satisfaction unfolds over one year of studying while it takes another year when dissatisfied students have higher tendencies for dropping out of their university degree program. All our results cannot be alternatively explained by individual differences in age, gender, migration background, GPA, number of studied STEM subjects, study time, and number of participations in the present study.

5. Theoretical implications

A persistent question in the field of procrastination research is whether students' procrastination is a cause or a consequence of dissatisfaction and dropout intentions in higher education. Various cross-sectional studies, which rely on correlative findings, do not permit conclusions about causal relations between these variables (see e.g., Balkis & Duru, 2016; Bäulke et al., 2022; Fritzsche et al., 2003; Grunschel et al., 2016). Our longitudinal study is the first to provide evidence that procrastination leads to dissatisfaction, which in turn leads to dropout intentions over the course of three years of studying. This is contrary to the reverse scenario.

We employed a longitudinal study design with multiple measurement points to assess students' procrastination, study satisfaction, and dropout intentions. This approach enabled us to examine the dynamic and processual causal interrelations between these variables. Accounting for temporal processes is crucial, as the most prominent models in procrastination and dropout research postulate that procrastination and dropout intentions depend on underlying psychological processes that evolve over time.

For instance, the temporal motivation theory (Steel, 2007; Steel & König, 2006) posits that the utility for starting a task (e. g., studying) depends on individual task-related expectancies (e.g., academic self-concept) and values (e.g., satisfaction with the subject of studying) in relation to the time available to complete the task as well as individual differences in the sensitivity for the delay. Over time, students prone to procrastination might engage more frequently in enjoyable activities instead of persisting with cognitively demanding tasks that require high levels of self-control (e.g., Ainslie, 1975; Lindner, Nagy, & Retelsdorf, 2018; Steel, 2007). This proposed temporal mechanism aligns with the assumption of the process model of self-control failure (Inzlicht et al., 2014). The model suggests that a key psychological mechanism linked to interruptions in goal-directed behavior is the shift from positive to negative emotional states over the course of time, making procrastination a likely predictor of dissatisfaction with studying. Our study provides evidence supporting this mechanism. Furthermore, Tinto's (1975) prominent dropout model proposes that dropout intentions develop over time, ultimately leading students to leave their programs. More specifically, our results align with Tinto's assumption (1975) that dissatisfaction might hinder students from academic integration, resulting in higher intentions to drop out from their university degree program.

In summary, examining the causal interrelations between procrastination and other psychological variables necessitates the use of longitudinal study designs and multiple measurement occasions. This approach allows for the tracking of psychological processes over time. Such a methodology is crucial for falsifying models of procrastination and dropout that explicitly posit that changes in one variable cause changes in other psychological variables over time. Therefore, we encourage researchers to replicate our findings, which indicate that procrastination leads to study dissatisfaction, subsequently resulting in dropout intentions over the course of three years of study. Such replication attempts would further validate and strengthen our understanding of these complex interrelationships.

6. Practical implications

The results of our FF-CLPM also have some practical implications. First, university institutions might implement intervention programs to help students reduce procrastination at the beginning of their university studies (van Eerde & Klingsieck, 2018), which can prevent them from perceiving higher levels of subsequent study dissatisfaction. Trainings in self-regulated learning strategies (e.g., Grunschel et al., 2018; Häfner et al., 2014) and emotion regulation (Schuenemann et al., 2022), cognitive behavioral therapy (Çelik & Odacı, 2018), and resource-based intervention programs can help to reduce academic procrastination while keeping it at a consistently low level throughout the course of study (for an overview, see van Eerde & Klingsieck, 2018). Second, in our study, procrastination was unrelated to subsequent dropout intentions, but our results showed that procrastination predicted study dissatisfaction and study dissatisfaction in turn predicted subsequent dropout intentions. The interrelation between study dissatisfaction and

dropout intentions might also depend on varying study conditions, as described in influential dropout models (Tinto, 1975). With regard to our investigated sample of teacher students, we already provided evidence that students' study satisfaction and dropout intentions also depend on the degree of integration of subject-specific and subject-didactic study contents in the curricula of student teacher education (Lindner & Klusmann, 2018). Additionally, enhancing the instructional quality (e.g., stimulating meaningful learning), offering learning environments in higher education that foster students' sense of autonomy, competence, and social connection, and showing appreciation for students' abilities by instructors appear to increase students' satisfaction with studying and decrease their dropout intentions (e.g., Carstensen et al., 2021; Feldman, 1989). To achieve this objective, policymakers could implement advanced organizational development programs at universities, such as the 'Qualitätsoffensive Lehrerbildung' in Germany, a national program aiming to sustainably improve teacher education through various projects and reforms (BMBF, 2022). Programs of this nature could incorporate strategies aimed at curbing students' procrastination while also enhancing the quality of curricula and study conditions within higher education.

7. Strengths and limitations

Three major strengths of the present study are the large time intervals between our measurement points, the sample composition including teacher students studying a variety of different main subjects, and the strict control for confounding influences in our main analyses (the FF-CLPM approach). It is assumed that the influence of procrastination on study satisfaction and dropout intentions is a long-lasting process that might vary across students studying different subjects (Scheunemann et al., 2022). The generalizability of our results is valid for teacher students and might also be valid for students studying STEM and non-STEM main subjects in general. In addition, the temporal patterns representing the influences of procrastination on study satisfaction as well as study satisfaction on dropout intentions over the course of three years provide a more comprehensive picture regarding the stability and interrelations of these variables that goes beyond the findings of previous research (e.g., Scheunemann et al., 2022). Controlling for age, gender, migration background, GPA, number of studied STEM subjects, study time and number of participations as well as for lag-2 effects ensured less biased estimates in our FF-CLPM, ruling out reverse causation between procrastination, study satisfaction and dropout intentions (VanderWeele et al., 2016).

Our post-hoc power analyses revealed a statistical power ranging from 67.5 % to 100 % for the parameter estimates in the FF-CLPM. This indicates that the power was not optimal (i.e., <80 %) for some effects. Although there are claims that power might be a problematic criterion (e.g., Zitzmann et al., 2023), we tentatively suggest that attempts to replicate our study should ideally draw on a larger sample of several hundred more participants. It has to be noted that data collection of the present study occurred before the COVID-19 crisis. Thus, our results are not representative for the relations between students' procrastination, study satisfaction, and dropout intentions during COVID-19 lockdowns. Research studies have demonstrated that self-control, a crucial aspect of procrastination, also serves as an essential personal attribute in regulating distress associated with lockdown measures (Lindner et al., 2022; Peixoto et al., 2021). During the COVID-19 crisis, students' negative emotions fostered procrastination (Rahimi & Vallerand, 2021), which in turn compromising their level of contentment with respect to both learning achievements (Melgaard et al., 2021) and overall life satisfaction (Peixoto et al., 2021). As these studies rely on cross-sectional data, exploring the impact of crisis on procrastination and its subsequent effects on study satisfaction and potential dropout intentions would be of great interest. Despite the significant impact of the COVID-19 crisis on individuals' procrastination and overall well-being, our findings suggest that there are negative consequences of procrastination on study satisfaction and of study satisfaction on dropout intention, even in non-crisis periods.

8. Conclusion

In this study, we examined individual differences in the longitudinal and possibly reciprocal associations between procrastination, study satisfaction, and dropout intentions over the course of three years of university education. To our knowledge, this is the first longitudinal investigation that provides evidence for the hypotheses suggesting that procrastination leads to dissatisfaction while dissatisfaction leads to dropout intentions over time, rather than the other way around. Our findings have practical implications for implementing prevention and intervention programs at universities that can assist students in decreasing procrastination, improving their well-being, and reducing their intentions to drop out of their university degree program.

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CRediT authorship contribution statement

Christoph Lindner: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Steffen Zitzmann:** Methodology, Writing – review & editing. **Uta Klusmann:** Funding acquisition, Writing – review & editing. **Friederike Zimmermann:** Funding acquisition, Writing – review & editing.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used ChatGPT in order to improve the language clarity and coherence of the manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Declaration of competing interest

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lindif.2023.102373.

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