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From delay to forgetting: How boredom and procrastination disrupt prospective memory

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Abstract

Appointments, dinner invitations, tasks to finish before a deadline: modern daily life is packed with future intentions that we accomplish with a cognitive ability named prospective memory (PM). Some of these tasks are less engaging than others, and we sometimes find ourselves putting them off to later, until we eventually forget about them. Despite extensive research on cognitive determinants of PM, emotional and self-regulatory factors remain less well understood. The present study investigated whether the association between intention-related emotions – specifically boredom – and PM is accounted for by self-regulatory failures such as procrastination. A sample of 102 adults (aged 19-62 years) completed a 30-day ambulatory assessment, reporting both daily and long-delay intentions and rating boredom and procrastination at trait and item levels. Mediation analyses indicated that boredom and procrastination were each associated with PM lapses, and that intentions perceived as boring were more likely to be postponed, which in turn was associated with more frequent PM failures. For long-delay intentions, boredom was primarily linked to PM through its association with procrastination, whereas for daily tasks, boredom showed both direct and indirect associations with PM performance. Notably, boredom proneness was also related to PM capacity through elevated trait procrastination, underscoring how chronic emotional states are linked with self-regulatory processes and suggesting that boredom can impair goal-achievement and everyday memory performance.

Keywords: Boredom, Procrastination, Prospective Memory, Ambulatory Assessment, Ecological Validity, Daily Diary

Introduction

Imagine watching your favourite series on a cozy Sunday night and suddenly a cold shiver running down your spine because you realize one important thing: your tax declaration is due at midnight. Despite setting a reminder on your phone already some time ago, you ignored it, because you were feeling bored and repeatedly putting off the task. This scenario illustrates a lapse in everyday prospective memory (PM), the ability to remember and execute future intentions, such as taking one's medication, attending appointments, or paying bills in time (e.g., Einstein & McDaniel, 1990; Kvavilashvili & Ellis, 1996). Over the past two decades, research on PM has expanded significantly, given its crucial role in everyday activities and its importance for maintaining functional independence in daily life (e.g., Brinkhof et al., 2024; Hering et al., 2018; Woods et al., 2012). In this context, and beyond primarily cognitive or neurobiological pathways, several factors have been identified as potential determinants of individuals' PM performance.

The use of compensatory strategies and external reminders, for instance, has been shown to enhance PM (e.g., Ihle et al., 2012; Masumoto et al., 2011; Matchanova et al., 2020). Yet, individuals may not always take full advantage of the opportunity to set reminders to optimize their PM performance (Scarampi & Gilbert, 2021), which raises the question whether other factors may be at play. Indeed, motivational aspects, such as task importance and social salience, seem to improve PM performance, as individuals allocate more attentional resources to tasks perceived as highly relevant (e.g., Kliegel et al., 2001; Penningroth & Scott, 2013). However, the impact of motivation varies across different types of PM tasks and age groups. For instance, younger adults' PM typically improves with increased task motivation, while older adults show more variable effects (e.g., Altgassen et al., 2010; Ball & Aschenbrenner, 2018; for reviews, see also Peter & Kliegel, 2018; Walter & Meier, 2014). Another area of interest is the effect of stress on PM, which has been examined in numerous studies, although the findings remain inconsistent

across different settings, tasks, and populations (e.g., Glienke & Piefke, 2016; Ihle et al., 2012, 2014; Schnitzspahn et al., 2022; for a systematic review, see Piefke & Glienke, 2017). In fact, some studies suggest that stress is associated with a depletion of cognitive resources, leading to impaired prospective remembering (e.g., Schnitzspahn et al., 2022). Conversely, other studies indicate that mild, acute stress can improve PM performance by enhancing motivation and focus (e.g., Nater et al., 2006). These divergent findings underscore the complexity of the factors influencing PM, highlighting the need to consider both the context and the potential additive or overlapping effects of multiple factors when evaluating their impact.

While laboratory-based research has contributed significantly to our understanding of PM and its underlying processes, it remains limited by its inability to reflect the complexity of contexts typically encountered in everyday life. Recent research has therefore emphasized the need for more real-life investigations to capture everyday PM, moving beyond controlled laboratory experiments to more ecologically valid approaches (e.g., Rummel et al., 2023; Rummel & Kvavilashvili, 2019; for a discussion on ecological validity in PM, see also Kvavilashvili & Ellis, 2004; Phillips et al., 2008). Ecological validity can be improved by combining daily-diary methods, which track everyday PM intentions, with ambulatory assessments that allow for a more time-sensitive examination of how contextual and individual factors affect PM in real-life settings. Despite substantial naturalistic research on factors such as stress and motivation, certain cognitive and emotional influences remain relatively underexplored in their impact on PM, particularly so procrastination and boredom. These factors are prevalent in everyday life and may play a significant role in how well individuals execute future intentions, yet they have received far less attention in the literature.

Procrastination and PM

Procrastination involves voluntarily delaying intended actions, even when aware of the potential negative consequences, and is often associated with failures in self-regulatory behaviour (e.g., Sirois & Pychyl, 2013; Steel, 2007). Longitudinal data even shows that procrastinators tend to avoid tasks they perceive as difficult or unpleasant, opting for short-term relief over long-term goals despite the negative costs in the long run (Tice & Baumeister, 1997). While procrastination has been well-studied in general task completion and decision-making, its specific impact on PM remains an emerging area of research.

Recent findings indicate that procrastination can already be observed in preschool children. Procrastination tendencies at this age appear to be negatively associated with executive functioning and future-oriented cognitive abilities, although the effects may change with age as self-regulatory abilities develop during early childhood (e.g., Fuke et al., 2023; Sutter et al., 2018). Building on the association between procrastination and self-regulatory failures, it has been demonstrated that certain personality traits, such as those considered as more relaxed or less well-organized (i.e., 'Type B' individuals), may be associated with a higher likelihood of procrastination and impaired performance on time-based PM tasks, especially under time constraints (Gan et al., 2023). In fact, this seems to be linked to increased cognitive demands, as these individuals struggle to manage attentional demands effectively. Adding to this, brain imaging research shows that individuals with higher levels of procrastination experience increased activity in fronto-central brain regions, indicating higher cognitive load during PM tasks, which may further impair their ability to execute intended actions (Zhuravlova et al., 2021).

Regarding more naturalistic task settings, Zuber and colleagues (2020, 2021) have shown that both self-reported and actual procrastination predict PM failures in younger adults.

Moreover, their studies provided further insight into how procrastination impacts PM through the identification of distinct procrastination profiles. According to their results, non-procrastinators performed best on PM tasks, while the highest rate of PM failures was observed in unconscious procrastinators (i.e., individuals with high actual but low self-reported procrastination). Interestingly, conscious procrastinators, who deliberately delay tasks while remaining aware of their intentions, exhibited an intermediate failure rate. The authors argue that this group's procrastination behaviour was less detrimental to PM performance, as these delays were more strategic and limited in duration, suggesting that not all procrastination is equally harmful and may even be considered relatively adaptive in some cases (e.g., Choi & Moran, 2009; Chowdhury & Pychyl, 2018). Unconscious procrastination, in contrast, can be characterized by a lack of metacognitive awareness and an inability to implement effective strategies, which contributed to their higher failure rates (see also Kuhlmann, 2019; Scarampi et al., 2024). Moreover, these findings suggest that actual delay, rather than subjective perceptions of procrastination, is a more informative predictor of PM performance.

Boredom and PM

Boredom is a state that occurs when there is a mismatch between the individual goals and the current activity (Tam et al., 2021). More broadly, boredom often arises when a task feels either too easy, too difficult, or lacks perceived value (e.g., Eastwood et al., 2012; Pekrun et al., 2010; van Tilburg & Igou, 2012; Westgate & Wilson, 2018). This experience is familiar in situations where we are required to complete uninteresting activities, such as filling out forms or performing repetitive tasks. Importantly, boredom serves as a signal that we may not be making effective use of our resources, indicating a state of underutilised potential and inadequate engagement (e.g., Elpidorou, 2023; Wolff et al., 2024). For someone anticipating a tedious

activity, the feeling of boredom can trigger an urge to avoid the task. Engaging with a boring activity increases the need for self-control to start and persist with it, as boredom encourages the redirection of attention and resources elsewhere (Wolff & Martarelli, 2020). Far from being a mere annoyance, boredom plays a critical role in self-regulation (Bieleke et al., 2021).

Although relatively few studies have examined the relationship between boredom and PM, existing evidence suggests a generally negative impact, notably that less involving or engaging tasks are associated with lower PM performance. For instance, Cuttler and colleagues (2016) were able to show that impulsivity significantly predicted PM failures, particularly in contexts where attention wanes during prolonged or monotonous tasks. Difficulty in maintaining focus, especially during boring tasks, thus appears to be associated with lapses in laboratory PM. In a recent study, Chen and Rau (2022) highlighted that boredom impacts PM by diverting cognitive resources, particularly when tasks require sustained attention. Using EEG, they confirmed that brain activity mediated the effects of boredom on PM by disrupted attentional processes. In line with these findings, early research by D'Ydewalle (1995) already demonstrated that task engagement is predictive of PM performance in older but not in younger adults, which highlights age-related differences in the allocation of (available) cognitive resources, therefore making older adults potentially more vulnerable to the impact of boredom on PM. Yet, most research in this domain relies on laboratory-based assessments of PM, which further underpins the need for studies involving measures of real-life PM.

Particularly relevant in the context of PM, it is important to distinguish between boredom as a transient cognitive–affective state and boredom proneness as a relatively stable individual trait. State boredom, as described above, is a temporary state reflecting one's ability to engage and remain engaged with a certain activity. In contrast, boredom proneness refers to a stable

tendency to experience boredom more frequently and intensely (Farmer & Sundberg, 1986). Individuals who are high in boredom proneness struggle to attain satisfactory engagement, often due to dysfunctional self-regulatory processes (e.g., Elpidorou, 2018; Mugon et al., 2018). Complicating matters further, highly boredom-prone individuals are motivated to seek more rewarding activities but frequently fail to do so effectively (Martarelli et al., 2023). For everyday PM, this suggests that a boring intention may be even more difficult to engage with and to accomplish for boredom-prone individuals.

Boredom, Procrastination, and PM

In the preceding sections, the bidirectional links between boredom and PM, as well as between procrastination and PM, have been outlined. In addition to their individual effects on PM, boredom and procrastination are associated by a common avoidance-oriented motivational component. Boredom has been characterized as involving avoidance of effortful or seemingly meaningless activities. Boredom proneness, in particular, may reflect a difficulty in tolerating low-stimulation environments, which promotes avoidance of repetitive activities. Similarly, procrastination is often motivated by the desire to escape from aversive states or anticipated negative emotions, resulting in delay of goal-relevant actions. Specifically, this motivational overlap suggests that boredom may not only precede procrastination but actively contribute to avoidance-based disengagement from intended actions individuals may perceive as unstimulating or monotonous (Rebetez et al., 2018, see also Gerritsen et al., 2014; Mercer-Lynn et al., 2013). Indeed, previous research highlights that boredom is a significant predictor of procrastination behaviour, as demonstrated for both boredom proneness and state boredom (e.g., Sümer & Büttner, 2022; Teoh et al., 2021; Teoh & Wong, 2023). Supporting this relationship, neural evidence suggests that boredom and procrastination also share common brain mechanisms

(Wang et al., 2021), with prolonged engagement in a boring task linked to frontal EEG asymmetry patterns consistent with motivational withdrawal (Perone et al., 2019).

From a theoretical perspective, functional accounts of boredom conceptualise it as a signal to redirect attention toward more rewarding activities (Martarelli, Wolff, et al., 2021), consistent with opportunity cost models (Kurzban et al., 2013) and the expected value of control theory (Shenhav et al., 2013). In cost-benefit terms, boredom reflects a devaluation of the current activity relative to its perceived effort, increasing the subjective appeal of alternative activities. This re-evaluation process can promote disengagement in the form of procrastination, which may delay or prevent timely execution of intended tasks, thereby increasing the likelihood of PM lapses.

The distinction between trait and state levels of boredom and procrastination is critical for understanding their potential impact on PM. Trait procrastination reflects a stable, habitual tendency to delay tasks, while state procrastination occurs in response to specific situations (Ferrari, 2010). Similarly, trait boredom refers to a chronic sense of disengagement, whereas state boredom is a temporary emotional response to specific tasks or environments (Martarelli & Jost, 2024). Investigating both levels is essential because these constructs may operate differently across timescales, influencing PM through distinct mechanisms. Trait levels of procrastination and boredom may exert more consistent or broader effects on PM, whereas state levels likely influence PM only under specific conditions. For instance, individuals with high trait boredom may struggle with PM consistently across various tasks, as their chronic disengagement hinders the allocation of cognitive resources required for prospective remembering. In contrast, experiencing state boredom may only show impairments during particularly dull activities, making its effects more task-dependent (see also Westgate & Wilson, 2018). Investigating both

trait (between-person) and state (within-person) levels therefore not only tests whether effects are consistent across timescales, but it also clarifies whether observed associations are driven by stable individual differences, by situations, or by both.

Study Goals and Hypotheses

The present study investigated how boredom and procrastination are linked to PM in everyday life, using a 30-day ambulatory assessment in combination with questionnaire measures. Procrastination, as a failure of self-regulation, and boredom, as a state that can reduce motivation and attention, have both been linked to poorer PM performance. The well-documented association between boredom and procrastination suggests that procrastination may help explain part of the relationship between boredom and PM. This study aimed to examine whether procrastination mediates the association between boredom and PM. The proposed mediation pathway can be framed within cost-benefit models of self-regulation, which posit that task engagement depends on a trade-off between its perceived value and associated effort (e.g., Wolff & Martarelli, 2020). From this perspective, boredom reflects a devaluation of the intended task, increasing the relative appeal of alternative activities. This disengagement, in the form of procrastination, may delay or prevent timely intention execution. More precisely, as both factors are linked to reduced self-regulation and task engagement, we hypothesised that higher levels of boredom and procrastination would be associated with worse PM. Additionally, the present study explored how trait and item-levels of these factors relate to PM and whether these associations vary for different intention retention intervals, contributing to a more fine-grained understanding of the mechanisms underlying how effectively individuals manage their future tasks in real-world settings.

Methods

Participants

The current sample comprised 102 adults (M_{age} = 37.26, *SD* = 8.50, age range 19 - 62 years, 84 women). All participants were recruited from an internal pool of volunteers and were considered eligible if they were (a) aged 18 years or older, (b) French- or German-speaking, and (c) enrolled in the undergraduate psychology program. Enrolment and data collection took place in multiple waves between November 2023 and April 2024 in Switzerland. As compensation for their involvement, all participants received credits equivalent to a total of 4 hours of study participation. Table 1 illustrates the descriptive characteristics of the sample.

General Procedure

An ambulatory assessment approach was implemented to collect data using the smartphone application *movisensXS* version 1.5.23 (movisens GmbH, Karlsruhe, Germany). After signing the informed consent, participants received detailed instructions on how to install the application and synchronise it with the sampling scheme. Over a period of 30 days, participants first completed a baseline survey (Day 0) including sociodemographic information and a set of questionnaires on trait measures described below. They then followed a diary approach involving self-assigned intentions and daily momentary assessments for four consecutive weeks (Days 1-28). On the final day of the study (Day 29), participants again completed a set of trait questionnaires (for a visual representation of the study protocol, see Supplementary Material Figure S1).

Material

Prospective Memory

Daily Intention Diary. In both week 2 and week 4 of the study protocol, participants were asked to fill out a smartphone-based intention diary for five consecutive days each (for a

similar procedure, see Haas et al., 2022; Ihle et al., 2012). Every evening, a push notification reminded them to list their personal intentions and tasks for the next day in a questionnaire in the smartphone application. Participants received standardised instructions to record behavioural intentions that were specific and limited to the timeframe of the upcoming day. They were encouraged to include personally meaningful goals to capture the full range of everyday PM demands (including actions like remembering to bring a letter to the post office, remembering to buy bread on the way home, remembering to call someone, or remembering to attend an appointment), but refrain from listing routine activities or intentions related to the study protocol. Daily intentions typically included activities such as attending scheduled appointments, completing household tasks (e.g., grocery shopping, paying bills), work-related deadlines, social commitments (e.g., calling family members, meeting friends), and health behaviours (e.g., taking medication, exercising). On the following evening, participants were presented with their previously reported intentions and were asked to state whether the intention had been completed or not.

The diary form was available every evening between 6:00 p.m. and 11:00 p.m., and a reminder was signalled by a phone alarm if the questionnaire had not been completed by 9:30 p.m. During the day, participants had no possibility of referring to the intentions they had noted.

Long-Delay Intention Diary. Similar to the daily intention diary, we also investigated participants' PM performance with longer delay intervals. At the beginning of week 1, participants were asked to report five personal intentions which they had planned for week 3 (i.e., two weeks later). At the end of week 3, participants were presented with the reported intentions and had to indicate for each of them whether it had been completed or not.

Trait PM. We have used the respective subscales of the following three instruments to determine different aspects of participants' PM capacity at the trait level: (a) the *Metacognitive Prospective Memory Inventory – short form* (MPMI-s; Rummel et al., 2019) and (b) the *Prospective and Retrospective Memory Questionnaire* (PRMQ; Smith et al., 2000) as self-reported measures of general PM abilities; and (c) the *If-Then-Planning Scale* (ITPS; Bieleke & Keller, 2021) to self-evaluate goal-directed behaviours with focus on seizing opportunities and overcoming obstacles. Each of the respective PM scales comprises eight items each, examples including "*I often forget appointments if no one reminds me or if I don't use a reminder, such as a calendar or diary.*" (PRMQ), "*I receive overdue notifications because I forget to pay bills on time*." (MPMI-s), and "*I plan how I can best achieve my goals*." (ITPS). The items of the PRMQ and the MPMI-s followed a five-point Likert scale, items of the ITPS a seven-point Likert scale. For both the MPMI-s and the ITPS, higher total scores are related to better subjective PM. As for the PRMQ, lower total scores are an indicator of better PM as scoring high on this scale represents more frequent problems in self-reported PM. All three subscales showed acceptable scale reliability (Cronbach's alphas: $\alpha = .781$ [PRMQ], $\alpha = .781$ [MPMI-s], and $\alpha = .763$ [ITPS])

Boredom

Trait Boredom. We assessed trait boredom using the *Short Boredom Proneness Scale* (SBPS; Martarelli et al., 2021, 2023; Struk et al., 2017). This questionnaire comprises eight statements (e.g., "*I find it difficult to entertain myself*."), for each of which participants must indicate their level of agreement on a seven-point Likert scale. The resulting total score ranges from 8 (low boredom proneness) to 56 (high boredom proneness), with the scale showing good reliability (Cronbach's alpha: $\alpha = .851$).

Item-Level Boredom. For each of the prospective intentions reported in the memory diary, participants were asked to indicate in how far the task was boring for them, ranging from 0 (not at all boring) to 7 (very boring). For long-delay intentions, item-level boredom was assessed both before (week 1) and after (week 3) planned execution of the intention. For intentions in the daily diary (week 2 and week 4), item-level boredom was only assessed at the intention-check (i.e., *after* the planned accomplishment).

Procrastination

Trait Procrastination. We used the Pure Procrastination Scale (PPS; Rebetez et al., 2018; Steel, 2010; Svartdal et al., 2016) to assess self-reported trait procrastination. This questionnaire measures trait procrastination as a single overarching construct through 11 statements. Participants rate on a five-point Likert scale in how far these statements apply to them (1: "rarely or not true for me" – 5: "often or always true for me"). The statements of the PPS capture two dimensions of procrastination, namely *'voluntary delay'* (i.e., actively putting off actions or decisions; "*I delay making decisions until it is too late*.") and *'observed delay'* (i.e., passive and unintentional behaviour of putting off actions; "*I do not get things done in time.*"). All items are summed to calculate a total score, ranging from 11 (low trait procrastination) to 55 (high trait procrastination), with the scale showing excellent reliability (Cronbach's alpha: $\alpha = .920$).

Item-Level Procrastination. For each of the prospective intentions reported in the memory diary, we assessed subjective and objective aspects of participants' procrastination behaviour: Regarding subjective procrastination tendencies (i.e., *voluntary delay*), participants were asked to rate the probability of postponing the accomplishment to a later point on a five-point Likert scale (1: "not at all likely" - 5: "extremely likely"). Regarding objective

procrastination (i.e., *observed delay*), for each of the intentions, participants had to indicate at what period of the day they planned on executing the task (i.e., in the morning before noon, in the afternoon between 12 p.m. and 6 p.m., or in the evening after 6 p.m.). If applicable for the specific intention, they were able to additionally specify an exact time. During the intention-check, we asked participants to report at what time they had completed the intention. We used this information to identify the actual procrastination behaviour, i.e. whether they had completed the intention during the same period of the day they planned on doing so. Additionally, if indicated, we computed the time difference to the original target time (in minutes).

Statistical Analyses

As a first step, we computed descriptive statistics of the sample characteristics both for the overall sample and separately for the language groups (cf. Table 1). Correlation coefficients were calculated to quantify associations between trait-level constructs and PM performance indicators obtained in the memory diaries on long-delay and daily intentions (cf. Table 2).

Trait-Level Mediation

We then performed mediation analyses to investigate the role of boredom and procrastination in PM at the trait level. More precisely, we computed three separate mediation models, one for each of the self-reported measures used to assess PM abilities as the outcome (i.e., one model using the PM subscale of the PRMQ, one model using the PM ability subscale of the MPMI-s, and one model using the ITPS). Predictor (boredom proneness) and mediator (trait procrastination) were identical in all three models. We report standardised estimates with their respective 95% confidence intervals (CI) and significance values.

Multilevel Mediation

Subsequently, we investigated the impact of item-level boredom and procrastination on PM in the intensive longitudinal data collected in the memory diaries. Following McNeish and MacKinnon (2022), we computed multilevel mediation models using a dynamic structure equation modelling framework (Asparouhov et al., 2018; Hamaker et al., 2018; McNeish & Hamaker, 2020), which provides a unique combination of time-series analysis, multilevel and structural equation modelling to analyse intensive longitudinal data, where multiple successive observations (i.e., within-person, level-1) are nested within individuals (i.e., between-person, level-2). As this type of modelling estimates within-person effects that also appear as latent variables at the between-person level and can be used to predict between-person outcome variables, it allows to simultaneously model both direct influence at the intraindividual level and interindividual differences in a single statistical model. For the present analyses, we ran models with 5,000 iterations and a thinning of 10. We used posterior distributions and their corresponding 95 % credible intervals (CrIs) to draw inferential conclusions for parameter estimates, meaning that when zero is not included in the CrIs, estimated parameters are considered as different from zero.

In a first multilevel mediation model, we analysed the influence of item-level boredom and procrastination on PM performance in a total of 490 long-delay intentions reported by 98 participants (*long-delay intentions*). Four participants were excluded from these analyses because they did not complete the memory diary for long-delay intentions. In addition to item-level boredom assessed at the initial listing of intentions in week 1, we also computed a model with boredom assessed at the intention-check at week 3 (i.e., after the planned accomplishment of the intention). Subsequently, we examined the influence of item-level boredom and procrastination on everyday PM in a total of 1367 intentions reported by 102 participants in the daily memory

diary (*daily PM intentions*). Overall model structure and decomposition in within-person and between-person components for the multilevel mediation models are shown in Figure 1.

For all multilevel mediation models, trait-level boredom and procrastination were entered as grand-mean centred predictors (i.e., positive scores represent individuals with above-average trait boredom/procrastination at the between-person level), and item-level boredom was entered as person-mean centred predictor to the model (i.e., higher scores indicate above-average boredom ratings at an individual level). For all models, the Bayesian estimation converged normally after the specified number of iterations and used two Markov chain Monte Carlo (MCMC) chains as the simulation-based approach to estimating posterior distributions for parameters and missing values. Posterior distributions of all parameters were symmetrical, trace plots of all posterior parameters indicated stability in the final solution and autocorrelation plots for each parameter indicated values quickly dropping to zero (Gelman et al., 2013; Plummer et al., 2006). The potential scale reduction (PSR) values stabilized near or below 1.01 for all models, suggesting adequate model convergence.

Transparency and Openness

This study's design, hypotheses, and analytic plans were not preregistered. We report our sample size, and describe all data exclusions (if any), manipulations, and all measures in the study. De-identified, pre-processed data and annotated analytical codes underlying the present analyses are openly available on the Open Science Framework at https://osf.io/4tdvs. The target sample size for this study was set at $N = 100$ following recommendations in the literature (e.g., Bolger et al., 2012; Fritz et al., 2024; Schultzberg & Muthén, 2018) and taking into account the available financial resources. Descriptive analyses and trait-level mediation were computed with jamovi version 2.6.13 (The jamovi project, 2024). Time-indexed intensive longitudinal data were

analysed using a multilevel mediation modelling approach in MPlus version 8.4 (Muthén & Muthén, 2017).

Results

Trait-Level Mediation

At the trait level, a first mediation analysis using the prospective subscale of the PRMQ as a measure of PM capacity revealed a significant direct effect of boredom on prospective memory (b = 0.14, SE = 0.06, 95% CI [0.02, 0.27], z = 2.25, p = .025). Higher boredom was associated with lower self-reported PM abilities (as higher scores on the PRMQ subscale are indicative of higher PM failure rates). The indirect effect of boredom was also significant (b = 0.11, SE = 0.04, 95% CI [0.03, 0.19], z = 2.74, p = .006), indicating that boredom affects PM both directly and indirectly through procrastination. The total effect was also significant (b = 0.25, SE = 0.05, 95% CI [0.15, 0.36], z = 4.87, p < .001).

Using the PM abilities subscale of the MPMI-s in the mediation analysis showed no direct effect of boredom on PM (b = -0.04, SE = 0.05, 95% CI [-0.15, 0.06], z = -0.82, p = .412). However, a significant indirect effect of boredom on PM through procrastination (b = -0.23, SE = 0.04, 95% CI [-0.32,-0.15], z = -5.33, p < .001), as well as a significant total effect (b = -0.28, SE = 0.05, 95% CI [-0.38,-0.18], z = -5.38, p < .001) were observed, indicating a full mediation of the effect of boredom on PM as measured with the MPMI-s.

A mediation model using if-then planning (ITPS) as a proxy for PM revealed no significant effects, neither for the direct (b = 0.01, SE = 0.01, 95% CI [-0.02, 0.03], z = 0.41, p = .685), nor for the indirect (b = -0.01, SE = 0.01, 95% CI [-0.03, 0.00], z = -1.72, p = .085) or total effect (b = -0.01, SE = 0.01, 95% CI [-0.03, 0.01], z = -0.79, p = .429).

In all three mediation models, boredom had a strong, positive effect on procrastination (PRMQ model: b = .65; MPMI-s model: b = .65; ITPS model: b = .64; all ps < .001). The negative effect of procrastination on PM was supported in the first two models (PRMQ model: b = .17, p = .003; MPMI-s model: b = -.36, p < .001), but not in the third model (ITPS model: b = -.02, p = .077). In sum, these results tend to support the hypothesis that procrastination mediates the relationship between boredom and PM at the trait level, with boredom impacting PM capacity negatively both directly and indirectly through increased procrastination. Potential reasons for divergence between the first two and the third model are discussed below.

Long-Delay Intentions

For the long-delay intentions, multilevel mediation analyses revealed that item-level boredom was not directly associated with PM performance, with the 95% CrI including zero (c'_i; β = .019, 95% CrI [-.064, .098]). However, boredom showed an indirect effect on PM success through item-level procrastination ($a_i \times b_i$; β = -.024, 95% CrI [-.051, -.001]). In fact, more boring tasks were more likely to be procrastinated (a_i; β = .167, 95% CrI [.086, .240]), which in turn predicted higher probability of PM lapses (b_i; β = -.230, 95% CrI [-.319, -.132]).

With regards to trait-level boredom and procrastination, distinct effects on long-delay PM performance were observed. While trait boredom showed no clear association with long-delay PM intentions at either the within-person or between-person level, trait procrastination was negatively associated with PM performance at the between-person level (β = -.437, 95% CrI [-.816, -.048]). Individuals with higher levels of trait procrastination were more likely to experience reduced PM success, independent of respective item-level boredom and procrastination.

Running an identical model with item-level boredom assessed at post-execution of the intention revealed similar effects for the links between item-level boredom and procrastination (a_i, β = .245, 95% CrI [.175, .312]), procrastination and PM success (b_i; β = -.176, 95% CrI [-.267, -.075]), and the between-person influence of trait-procrastination on PM performance (β = -.450, 95% CrI [-.823, -.070]). However, using post-execution ratings, item-level boredom showed a direct negative effect on long-delay intentions (c'_i; β = -.103, 95% CrI [-.189, -.021]), but no indirect effect through procrastination ($a_i \times b_i$; β = -.026, 95% CrI [-.058, .003]). Hence, it appears that item-level boredom ratings after (planned) execution are directly predictive of PM success rates, while item-level ratings assessed two weeks ahead of accomplishment only predict PM indirectly via increased procrastination behaviour.

Daily PM Intentions

For PM intentions assessed in the daily diary, multilevel mediation revealed that item-level boredom was directly associated with PM performance (c'_i; β = -.066, 95% CrI [-.111, -.021]). In fact, intentions that were rated as less boring were more likely to be accomplished. Moreover, boredom also showed an indirect effect on daily PM success through item-level procrastination ($a_i \times b_i$; β = -.014, 95% CrI [-.026, -.003]). Specifically, more boring tasks were more likely to be procrastinated (a_i; β = .138, 95% CrI [.091, .185]), which in turn predicted higher probability of PM lapses (b_i; β = -.329, 95% CrI [-.383, -.275]). Similar to the effects shown for long-delay intentions, between-person effects of boredom proneness were negligible, whereas higher trait procrastination negatively predicted daily PM performance (β = -.406, 95% CrI [-.578, -.182]).

Additionally, we examined whether the impact of boredom on daily PM remains when disentangling voluntary (i.e., subjective) and observed (i.e., behavioural) item-level

procrastination. This model revealed no direct effect of boredom on daily intentions (c'_i; β = .052, 95% CrI [-.163, .261]), but an indirect effect through subjective and observed procrastination was observed (β = -.012, 95% CrI [-.020, -.006]). Specifically, more boring intentions were associated with a higher tendency to be procrastinated (β = .137, 95% CrI [.090, .184]), which were associated with a higher actual procrastination (β = .317, 95% CrI [.264, .369]), which in turn made them less likely to be accomplished (β = -.818, 95% CrI [-.862, -.772]). Subjective procrastination and actual observed procrastination behaviour were moderately correlated ($r(1365) = .286$, $p < .001$). Model structure and detailed path results are shown in Figure 2.

Discussion

Building on existing work on multiple influences of everyday PM, the present study set out to investigate how boredom and procrastination – both independently and in combination – relate to prospective remembering. Additionally, using an ambulatory assessment procedure over a period of 30 days, we explored whether and how trait and item-levels of these factors differentially impact PM. Consistent with our hypotheses and prior literature, the present results suggest that boredom and procrastination are associated with impaired PM performance. One major finding emerging across all the mediation analyses performed is that boredom may affect PM both directly and indirectly through increased procrastination.

Specifically, at the trait level, the association of boredom proneness with memory abilities was either partially (i.e., for PRMQ) or fully mediated (i.e., for MPMI-s) through increased trait procrastination. For the ITPS, neither the direct nor the indirect effect of boredom on the propensity of if-then planning was significant. This result may be explained by the fact that if-then planning, also referred to as implementation intentions (Gollwitzer, 1999; Gollwitzer

& Sheeran, 2006), can be seen as a skill or strategy that is employed regardless of one's motivational state. As such, it may allow individuals to overcome self-regulatory difficulties, induced by boredom or procrastination. Unlike overall PM abilities (i.e., PRMQ and MPMI-s), which were highly correlated (see Table 2), if-then planning appears to tap into different aspects of future-oriented planning. It may therefore be considered less reliant on memory and more procedural/automatised (Bieleke & Keller, 2021; Sheeran, 2002). It is possible that individuals with higher boredom proneness might not necessarily show reduced if-then planning unless they fail to use the strategy effectively (but see also Bieleke et al., 2022; Wolff et al., 2022). Specifically, individuals may be bored or demotivated but are still able to carry out a rather automatic response ('if-then') to a specific cue, whereas this might not be the case if top-down memory processing is necessary to execute the PM intention.

At the item level, results revealed that the impact of boredom on daily PM intentions persists when separating procrastination into the subjective ('voluntary') likelihood to postpone a task and the objective ('observed') delay in carrying it out. Although boredom did not have a direct effect on PM performance in this refined model, its indirect effect remained robust. Specifically, intentions perceived as more boring were more likely to be voluntarily delayed, which in turn predicted a greater actual delay in task execution, ultimately resulting in lower PM success rates. This suggests a two-step process, where more boring intentions first trigger anticipated procrastination before enacting it, highlighting the importance of differentiating between subjective and behavioural aspects of procrastination, which were only moderately correlated in the present study. These findings align with previous research demonstrating that individuals' self-reported (i.e., conscious) procrastination may diverge from their actual delaying behaviour (i.e., unconscious procrastination), with the latter being a more robust predictor of PM

lapses (Zuber et al., 2020, 2021). From an applied perspective, interventions targeting to enhance PM may need to address both the perception (i.e., subjective anticipation of delaying a task) and the behavioural tendencies (i.e., actual observed delaying) of procrastination, preventing a self-fulfilling pathway of boredom and delay, and consequently improving everyday task performance.

Previous research suggests that individuals with higher boredom proneness might potentially struggle to engage in more boring tasks/intentions (e.g., Eastwood et al., 2012; Pekrun et al., 2010; Raes et al., 2024). However, the present results do not support this assumption. Although boredom proneness considerably contributed to trait PM abilities via its indirect effect through trait procrastination, it did not consistently emerge as a direct predictor of everyday PM lapses and was not related to item-level boredom of real-life intentions. Specifically, while a chronic tendency to feel bored increased the risk of procrastination (and thereby indirectly undermined PM performance), the contextual experience of boredom (i.e., linked to each specific intention) appears to be determining whether intentions are accomplished successfully. Because boredom proneness tends to manifest across a wide range of contexts, its effect may be diminished by varying novelty, challenges, or personal relevance associated with an individual's daily life. For instance, even highly boredom-prone individuals may remain engaged in tasks they perceive as personally meaningful. Relatedly, boredom-driven procrastination might serve as a way to avoid unproductive or irrelevant activities; however, in cases of necessary intentions like medical appointments, bill payments, or work deadlines, such avoidance can have negative consequences. Integrating this perspective allows for a better understanding of how emotional and motivational dynamics jointly impair prospective remembering, particularly in situations requiring sustained attention and self-regulation. As a

result, the present findings suggest that interventions aiming at improving PM should not only address boredom proneness but should also enhance task-related engagement by increasing for example perceived relevance.

Our primary model positions procrastination as a mediator linking boredom to PM failure, yet alternative explanations merit consideration. Boredom may impair PM performance through multiple pathways, including disruption of emotion regulation strategies. Recent meta-analytical findings demonstrate that effective emotion regulation strategies require cognitive effort that might otherwise support PM performance (cf. Toh et al., 2024). When individuals experience boredom, they may engage in effortful regulatory attempts (e.g., trying to force engagement with uninteresting tasks) or may avoid regulation altogether, allowing boredom to persist and interfere with attention and memory processes. Additionally, boredom may signal conflict between current activities and personal values or goals, creating a form of cognitive dissonance that consumes mental resources. Such shifts in effort allocation could then impair the executive functions necessary for successful PM, including maintaining intention activation, monitoring for retrieval cues, and coordinating ongoing task performance with intention execution. Future research should examine these alternative pathways alongside procrastination-mediated effects to develop a more comprehensive understanding of how boredom influences cognitive performance in everyday contexts.

Limitations and Methodological Considerations

An important limitation to consider is the reliance on self-reported measures for boredom and procrastination. Particularly for periods spanning intervals of several days or weeks, such as the long-delay intentions in the present study, individuals' reports may be affected by underreporting of PM tasks (e.g., in memory diaries with a free reporting format) or by over-

/underestimation of procrastination deviation due to recall bias or false memory. Although our modelling was based on theoretical assumptions, the correlational nature of our study limits causal interpretations, allowing us only to speculate about the direction of effects. Moreover, the cross-sectional nature of our measures, compared to a temporal separation, may introduce bias to the estimation of direct and indirect mediation paths (see also Maxwell et al., 2011). Future research may consider incorporating more objective metrics, such as wearable devices or digital task tracking, to ensure temporal separation of measurements and to validate and extend the present findings to other task-related factors by examining time-lagged effects (e.g., Phillips et al., 2008; Rummel & Kvavilashvili, 2019).

A novel aspect of this study was the assessment of boredom at multiple time points relative to intention accomplishment. In fact, boredom ratings assessed (much) in advance of task execution predicted procrastination tendencies, supporting the idea that anticipatory boredom potentially promotes avoidant behaviour, which in turn lowers PM successes. Conversely, post-execution boredom ratings emerged as a direct predictor of PM performance, and it is therefore likely that these ratings represent a more accurate reflection of actual task engagement (see also Levine & Safer, 2002; Nisbett & Wilson, 1977). The temporal dissociation suggests that individuals may recalibrate their boredom assessments based on task outcomes, potentially reappraising the effort and engagement required to accomplish the intention. Future studies could explore these retrospective reappraisal processes – for boredom as well as other emotional, affective, and cognitive factors – and their implications for PM interventions.

Lastly, another important methodological aspect is related to the temporal dimension of the intention itself. Daily tasks often require immediate and repeated attention, which may explain why they were more susceptible to the direct effects of boredom. In contrast, long-delay

intentions, characterized by their larger planning horizon, were influenced primarily by procrastination. These findings are in line with previous research suggesting that longer temporal delays of task execution may modulate the importance of self-regulatory and attentional factors in PM (e.g., Hicks et al., 2000; Provenzano et al., 2024; Rummel et al., 2023; Ślusarczyk et al., 2018; Wilson et al., 2020). In fact, participants in the present study descriptively performed less well on intentions spanning over several weeks compared to daily intentions, thereby extending previous research using delay intervals of 24-48 hours after listing of the intention (e.g., Rummel et al., 2023). Future studies would thus need to consider that intentions with different task horizons may be affected differently by task-specific characteristics (and their associated anticipatory/forecasting abilities related to emotional and affective components, as mentioned previously).

Constraints on Generality

Although these results are informative, several factors may limit generalizability. First, the study drew on a sample that was WEIRD (Western, educated, industrialized, rich and democratic; Henrich et al., 2010), and – although not specifically assessed – likely not clinically selected or ethnically diverse. In addition, participants were distance-learning students who balanced university coursework with regular (full-time) employment, therefore potentially introducing a bias toward individuals with higher self-discipline and established routines. While these sample characteristics might enhance real-world applicability compared to samples with full-time students, future research involving more diverse or potentially clinically relevant populations is needed to gain deeper insight into the relationship between boredom, procrastination, and PM.

Conclusion

In conclusion, the present study shed light on the dynamics between boredom, procrastination and PM, revealing how these factors individually and collectively influence the accomplishment of future intentions. By identifying boredom as both a direct and indirect predictor of PM failures, mediated through procrastination, the present findings underscore the importance of addressing emotional and self-regulatory barriers to enhance PM. Thus, particularly for tasks requiring sustained attention and delayed gratification, one important proactive strategy to counteract the effect of boredom on everyday memory and to foster improved self-regulation and greater success in achieving long-term goals appears to be a stronger focus on procrastination first, as mentioned in the timeless advice to *"Never put off until tomorrow what you can do today."*

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Endnotes

1: In line with a reviewer's suggestion, we explored whether boredom may act as a self-regulatory filter by correlating with the subjective importance of accomplishing the intention. However, these exploratory analyses revealed only weak or inconsistent associations between perceived importance and boredom. While we chose not to report these exploratory findings in detail, they underscore the need for future studies to incorporate explicit ratings of task utility and necessity to more clearly differentiate adaptive disengagement from maladaptive delay.

Competing interests

The authors report no competing interests.

Ethical approval

The present study was approved by the ethics committee of UniDistance Suisse (decision protocol: 2023-10-00001, Date: November 6, 2023). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Informed consent

All participants provided written informed consent upon enrolment in the study, i.e., one day prior to the start of individual data collection (see Procedure section above). Informed

consent covered participation in the present study, as well as use and publication of anonymized data.

Data availability

The study design, hypotheses, and analytical plan were not preregistered. De-identified data and annotated analytical codes are openly available at the Open Science Framework (OSF), https://osf.io/4tdvs.

Author information

Author contribution: M.H.: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing - Original draft, Writing - Review & Editing, Visualization, Project administration. C.M.: Conceptualization, Methodology, Validation, Writing - Review & Editing, Visualization, Project administration.

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Table 1

Sample Characteristics and Descriptives of Affective and Cognitive Measures for the Overall Sample and per Language Group

	Overall sample (n = 102)	German speakers (n = 55)		French speakers (n = 47)	
	M (*SD*)	*M* (*SD*)	Range	*M* (*SD*)	Range
Age	37.26 (8.50)	37.31 (9.06)	19 - 62	37.19 (7.90)	21 - 52
Education (years)	17.40 (4.19)	17.42 (4.83)	10 - 30	17.38 (3.36)	9 - 26
Employment (%)	79.75 (19.82)	76.97 (19.15)	30 - 100	82.57 (20.34)	40 - 100
PRMQ (PM subscale)***	21.01 (5.16)	19.38 (4.30)	10 - 28	22.96 (5.47)	13 - 36
MPMI-s (PM subscale)	30.11 (5.21)	30.44 (4.11)	18 - 37	29.27 (6.28)	16 - 39
ITPS (planning)	4.97 (0.86)	4.90 (0.75)	3 - 7	5.05 (0.97)	2 - 7
PPS (trait procrastination)	28.79 (9.49)	28.40 (9.49)	12 - 52	29.26 (9.56)	11 - 54
SBPS (trait boredom)	20.61 (8.85)	19.15 (8.73)	8 - 47	22.32 (8.76)	9 - 45
EMA compliance rate	0.85 (0.15)	0.86 (0.15)	0.21 - 1	0.84 (0.14)	0.39 - 1
PM performance (long-delay diary)	0.69 (0.22)	0.69 (0.25)	0 - 1	0.69 (0.20)	0.20 - 1
PM performance (daily diary)	0.74 (0.16)	0.74 (0.17)	0.29 - 1	0.73 (0.15)	0.33 - 0.94

Note. PRMQ = Prospective and Retrospective Memory Questionnaire (higher values represent lower abilities); MPMI-s = Metamemory Prospective Memory Inventory – short (higher values represent better abilities); ITPS = If-then planning scale (higher values represent better abilities);

PPS = Pure Procrastination Scale; SBPS = Short Boredom Proneness Scale; EMA compliance rate = average of completed prompts in the ambulatory assessment; PM performance = mean of accomplished intentions reported in the memory diary on long-delay and daily intentions, respectively. Distribution of sex: German speakers: n = 10 men / n = 45 women; French speakers: n = 8 men / n = 39 women. Significant differences between language groups are indicated by an asterisk. *** $p < .001$. ** $p < .01$. * $p < .05$.

Table 2

Correlations of Trait Measures and Real-Life Prospective Memory Performance Indicators

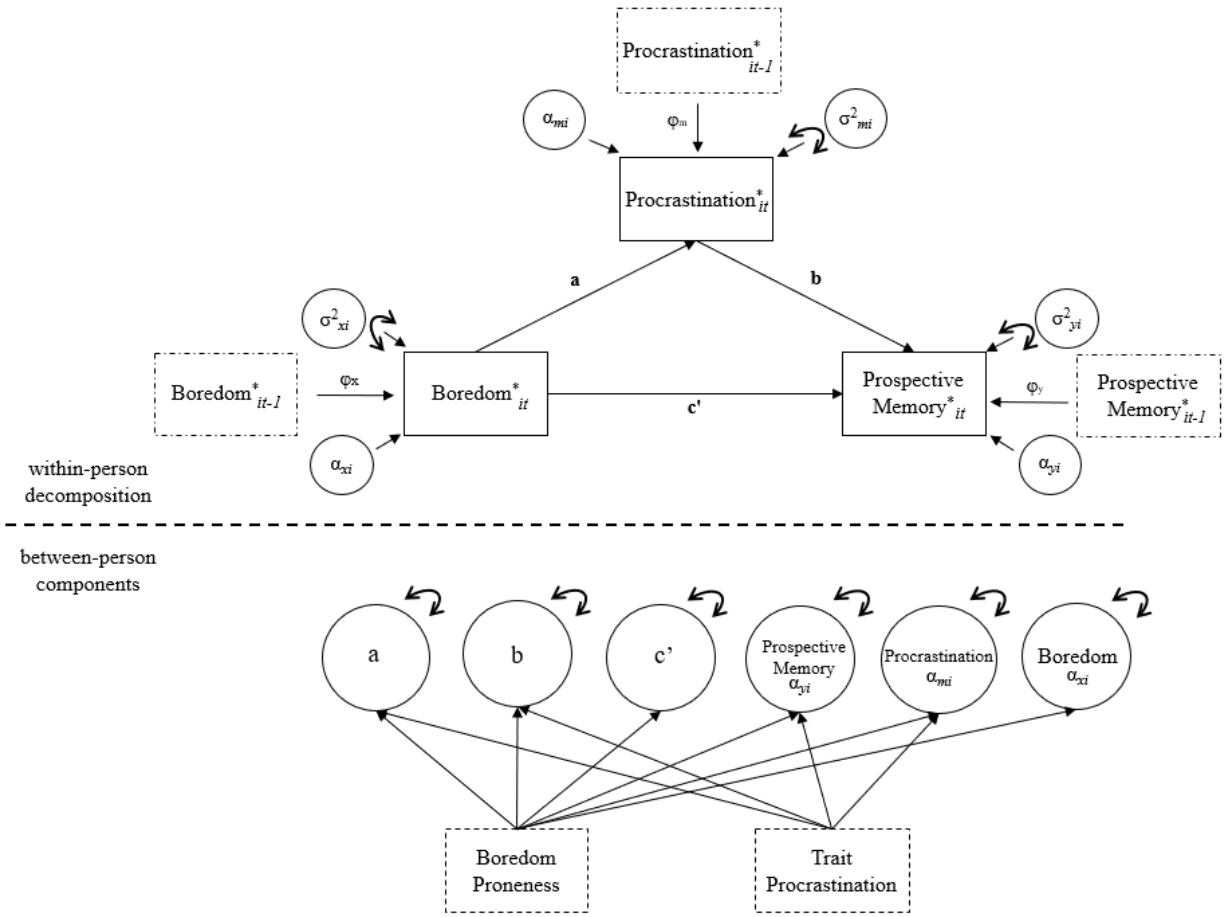
	PRMQ	MPMI-s	ITPS	SBPS	PPS	Long-delay PM
PRMQ (PM subscale)	—					
MPMI-s (PM subscale)	-.670***	—				
ITPS (trait planning)	-.069	.188	—			
SBPS (trait boredom)	.419***	-.437**	-.083	—		
PPS (trait procrastination)	.497***	-.717***	-.206*	.614***	—	
PM performance (long-delay diary)	-.302**	.395***	.086	-.319***	-.423***	—
PM Performance (daily diary)	-.364***	.420***	.152	-.375***	-.511***	.387***

Note. PRMQ = Prospective and Retrospective Memory Questionnaire (higher values represent lower abilities); MPMI-s = Metamemory Prospective Memory Inventory – short (higher values represent better abilities); ITPS = If-then planning scale (higher values represent better abilities); SBPS = Short Boredom Proneness Scale; PPS = Pure Procrastination Scale; EMA compliance rate = average of completed prompts in the ambulatory assessment; PM performance = mean of accomplished intentions reported in the memory diary on long-delay and daily intentions, respectively.

*** $p < .001$. ** $p < .01$. * $p < .05$.

Figure 1

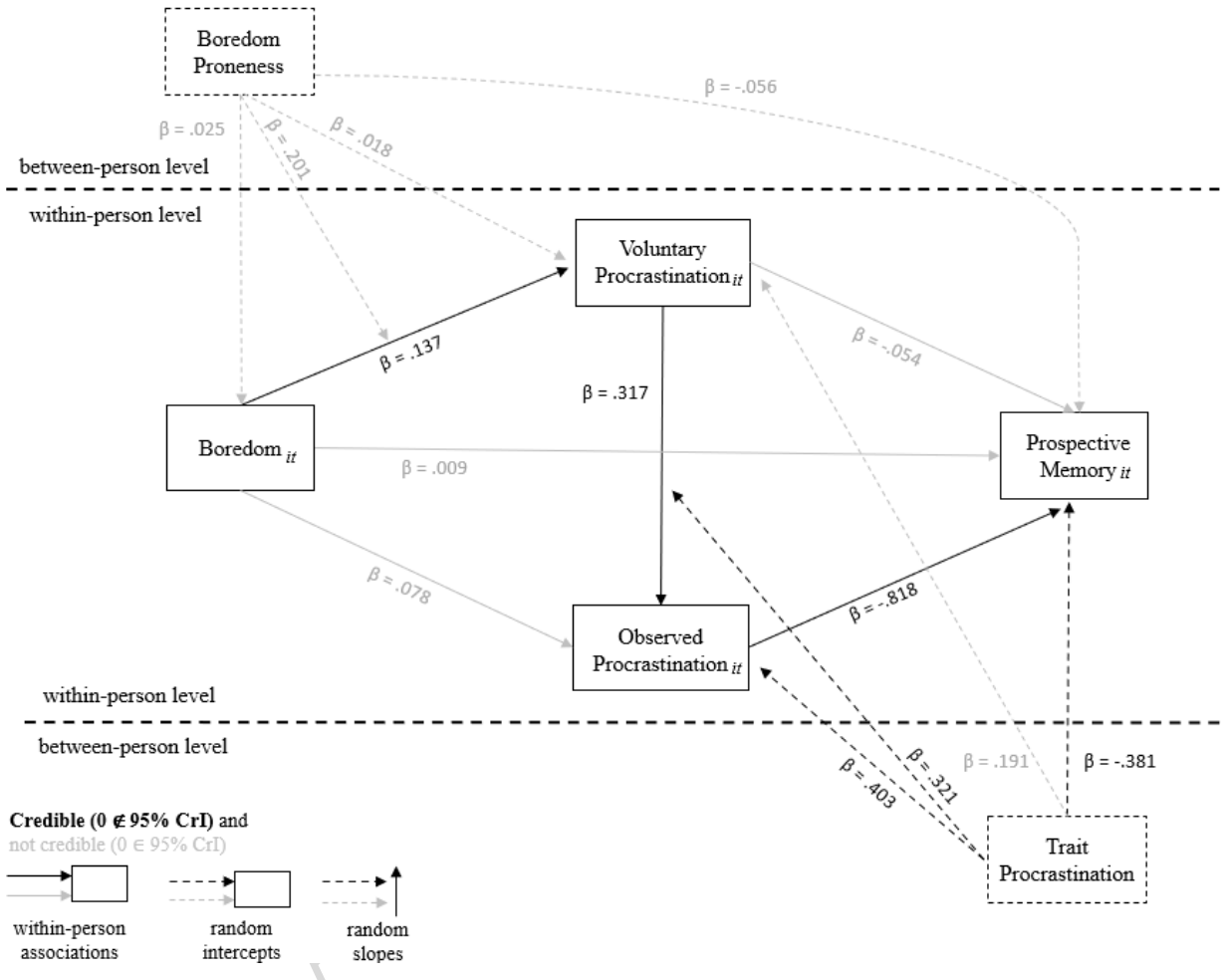
Multilevel Mediation Model Structure and Within-Person and Between-Person Decomposition



Note. Decomposition of constructs for an individual *i* at time *t* as $PM_{it} = \alpha_i + PM^*_{it}$ where α_i is the mean probability for PM success for the individual *i*, and PM^*_{it} is the deviation from this mean at time *t*. Autoregressive parameters are denominated as φ. On the within-person level, we estimated the direct effect of item-level boredom and PM success (c'), as well as the indirect effect of boredom on PM via item-level procrastination ($a_i \times b_i$) by regressing PM^*_{it} on the respective variables. On the between-person level, the influence of observed trait boredom and procrastination (dashed rectangles) on latent between-person means and mediation components are examined. Given the within-day assessment of key constructs in the present study, directional effects depicted in the within-person decomposition of the model are to be considered as contemporaneous covariation between variables rather than causal influence.

Figure 2

Multilevel Mediation Model of Voluntary and Observed Procrastination in Daily Intentions



Note. Multilevel mediation model illustrating within-person effects of an individual *i* at time *t* of item-level boredom and voluntary and observed item-level procrastination on daily prospective memory intentions (rectangles with solid borders), as well as the cross-level between-person effects of trait boredom and procrastination (rectangles with dashed borders). Pathways with the 95% CrI that exclude zero are represented in black, while those with 95% CrI including zero are represented in grey. Dashed arrows from trait-level variables to item-level variables represent random intercepts (i.e., trait effects on average levels), while dashed arrows from trait-level variables to associations between item-level variables represent random slopes (i.e., trait effects on the strength of within-person relationships). This modelling approach captures individual differences in both average levels and within-person associations of boredom,

procrastination, and prospective memory. Given the within-day assessment of key constructs in the present study, directional effects depicted in the within-person decomposition of the model are to be considered as contemporaneous covariation between variables rather than causal influence.