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# An experimental investigation of daily mental contrasting with implementation intentions and goal motives in reducing bedtime procrastination: a registered report

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**ABSTRACT**

**Objectives:** Mental contrasting with implementation intentions (MCII) is an effective self-regulation strategy for goal pursuit. Although it is a quick and cost-effective strategy, most of its applications have consisted of single-time training. Building on the existing research on bedtime procrastination, we propose that daily MCII applications can lead to more efficient pursuit of bedtime goals. Furthermore, we evaluate the conditions where MCII training could be more advantageous for people with different types of goal motives.

**Methods and Measures:** We recruited 297 participants *via* Prolific and randomly allocated participants into either daily MCII or single MCII groups for a week-long diary study. We measured goal motives, goal-regulatory variables, bedtime procrastination, and affect to test our hypotheses. We conducted a multilevel structural equation modelling using *Mplus*.

**Results:** Participants who completed MCII daily reported less bedtime procrastination than individuals who performed MCII one-off at the start of the week. Participants experienced increased positive affect and decreased negative affect when they procrastinated less. Autonomous goal motives were not associated with bedtime procrastination.

**Discussion:** Daily MCII appears as an effective and easy-to-implement strategy helps reducing bedtime procrastination. Future research should test the effectiveness of daily MCII in other contexts.

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Mental contrasting with implementation intentions; bedtime procrastination; goal motives; goal-regulatory variables; affect

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## Introduction

Among a sample of more than 60,000 participants, sleep regularity was found to be a stronger predictor of all-cause mortality risk than sleep duration itself (Windred et al., 2024). Bedtime procrastination, which is the act of 'needlessly and voluntarily delaying going to bed, despite foreseeably being worse off as a result' (Kroese et al., 2016a, 2016b, p. 102), jeopardises sleep regularity and poses a threat to sleep health by disrupting regular sleep times. Bedtime procrastination is pervasive in modern society. For instance, in a representative sample of the Dutch population ($n = 2{,}431$), 53% of participants indicated delaying going to sleep at their intended bedtime. In their meta-analysis of bedtime procrastination, Hill et al. (2022) synthesised 43 studies that investigated the correlates of bedtime procrastination. Going to sleep later than intended was largely related to less sleep (Fisher's $z = -0.31$, $p < .001$), poorer sleep quality (Fisher's $z = -0.35$, $p < .001$), and greater daytime fatigue (Fisher's $z = 0.31$, $p < .001$). Regarding individual differences, people who procrastinate going to sleep tend to have lower levels of self-control (Fisher's $z = -0.39$, $p < .001$) and an evening chronotype (Fisher's $z = 0.43$, $p < .001$). People with an evening chronotype prefer sleeping later in the evenings and exhibit higher intraindividual variability (i.e. less consistency) in their sleep and wake times (Bei et al., 2016). These results corroborate the negative sleep outcomes of bedtime procrastination and suggest that bedtime procrastination relies partly on inadequately adjusting one's behaviour and partly on one's biological clock. Thus, there is an urgent need to identify effective interventions for reducing bedtime procrastination that are cost-effective and easily administered without requiring any professional assistance. The present study addresses this issue.

The behavioural side of bedtime procrastination includes going to sleep at a time later than what was originally planned; however, there are two other criteria that need to be met to classify the delay as a valid case of bedtime procrastination (Kroese et al., 2016a, 2016b). The second criterion of bedtime procrastination is absence of a valid reason for the bedtime delay. A delay can be considered as bedtime procrastination only if people had no reasonable alternative but to go to sleep at a later time, such as looking after a dependent for the night or feeling sick. The third criterion is expecting to be left physically or psychologically deprived the next day if bedtime is delayed. Physical or psychological deprivation refers to experiencing negative effects on one's body or mind because of insufficient or poor sleep. Physical manifestations might include feeling unusually tired, having trouble concentrating, or experiencing a weakened immune response, making one more susceptible to sickness. Psychological deprivation could lead to feelings of irritability, stress, or a general sense of being unwell or unhappy. People need to acknowledge the detrimental effects of sleep delay (e.g. feeling tired and agitated) and expect such effects to occur the next day; if there are no such expectations (e.g. planning to sleep through the whole Sunday morning), the delay cannot be considered as bedtime procrastination. Bedtime procrastination inherently involves two time points: intended and actual bedtime. If a person does not have a specific bedtime to go to bed (i.e. intended) because they do not expect to be physically or psychologically deprived in any sense the next day, the conditions required to constitute a delay as bedtime procrastination would not be present (i.e. missing intended bedtime). Therefore, it is crucial to have a person's

expectations regarding the possible detrimental effects of going to sleep later than one intends.

Current methodological efforts to operationalise bedtime procrastination are often incongruent with the conceptual definition outlined above. The bedtime procrastination scale (Kroese et al., 2014) is the most widely used instrument for measuring bedtime procrastination (e.g. administered by 95% of eligible studies, Hill et al., 2022). However, this instrument is unable to capture whether or not a delay was accompanied by a valid reason and expectations of being physically or psychologically deprived. Furthermore, the scale is likely to reflect the trait-like features of bedtime procrastination (Hill et al., 2022), which is a considerable limitation given that approximately 75% of variation in daily bedtime procrastination levels occurs at the within-person level (Kühnel et al., 2018). Hence, procrastination behaviour is most appropriately assessed by considering an individual's night-to-night fluctuations in sleep time. The appropriate measurement of bedtime procrastination is a crucial limitation that needs urgent attention, as the assessment of functional interventions for bedtime procrastination can only be carried out when the outcome of interest is clearly quantified in alignment with conceptual definitions.

## *Tackling bedtime procrastination with mental contrasting with implementation intentions*

Bedtime procrastination can be broadly thought of as a failure to appropriately regulate one's sleep goal. The role of self-regulation is evident when thinking about the common situations that people might encounter around bedtime. For instance, one possible situation where people might have to self-regulate would be the moment they are confronted with the alluring 'watch the next episode' option; another would be realising they need to stop endlessly scrolling on their social media apps to go to sleep. People are subject to distractions or temptations when pursuing sleep goals that require putting in active effort to resist short-term pleasures, much like trying to stop themselves from indulging high caloric food when dieting.

MCII is an effective strategy for facilitating self-regulation of goal pursuit and has demonstrated efficacy for facilitating attainment of various health goals (e.g. unhealthy snacking, Adriaanse et al., 2010; smoking, Mutter et al., 2020), including sleep goals (Valshtein et al., 2020). MCII is used to guide goal pursuit by contrasting future and present goal states. According to Oettingen (2000, 2012), the mental contrasting process begins with the identification of a feasible goal that can be realised in the future. Participants then envision the most desirable outcome that would result from the fulfillment of this goal. Finally, the process concludes with the identification of obstacles in the current reality that stand in the way of attaining the desired goal. Mental contrasting facilitates goal pursuit by creating an association between future and reality and thereby strengthening goal commitment to reach that future state (Kappes & Oettingen, 2014). Although mental contrasting has shown effectiveness in various contexts and for diverse outcomes (for a meta-analysis, see Cross & Sheffield, 2019), individuals employing this strategy can encounter difficulties in realising their goals, even when they exhibit strong goal commitment. For instance, individuals may sometimes forget to take action or struggle to identify suitable opportunities for goal

attainment. To enhance the effectiveness of mental contrasting, Oettingen and Gollwitzer (2010) proposed complementing this strategy with implementation intentions (Gollwitzer, 1999). Implementation intentions involve establishing a connection between a specific cue related to a problem (e.g. 'if it is 10 pm') and a goal-directed response (e.g. 'then I will start getting ready for going to sleep'). These connections are created as 'if-then' plans, forging an association between a particular situation and an optimal response. The entire MCII process takes around five minutes to complete and requires no professional assistance. Previous experimental research has shown that, after a 3-week MCII-based intervention, participants went to sleep on average 33 min earlier than their baseline sleep times, whereas participants in the active control group (i.e. sleep hygiene info + positive thinking) reduced their bedtime procrastination by 14 min (Valshtein et al., 2020). The quick, cost-effective, and easily implemented nature of MCII offers distinct advantages over alternative interventions that are intensive in terms of both the time and resources required to administer them. Importantly, the minimally taxing nature of MCII means that interventions could theoretically be administered *ad infinitum* if repeated doses are found to offer additional benefit.

Although there is plenty of evidence that supports the general efficacy of MCII training in pursuing general life goals (Cross & Sheffield, 2019; Wang et al., 2021), extensions and optimisation of the training (e.g. daily MCII, MCII for multiple goals) have received less attention, even though preliminary findings suggest MCII can be adapted to these extensions. A recent meta-analysis of MCII interventions with diverse behaviours (Wang et al., 2021) reported that most studies administer a single application of MCII and that there is no clear evidence about optimal dosages (p. 8). Single and multiple applications of MCII have never been directly compared for any kind of behaviour, representing an essential gap in the literature which we aim to address in the current study by using bedtime procrastination as a target behaviour.

There is some evidence to support the benefits of repeated MCII training. Sailer et al. (2015) asked participants to re-write their implementation intentions plans with 7-days apart for three weeks to reinforce their goal pursuits and found that this repeated MCII training (vs. control) helped increase attendance (MCII group: $M = 68.75\%$, $SD = 12.50$, control group: $M = 35.94\%$, $SD = 30.21$, $p = .025$) and persistence (MCII group: $M = 87.50\%$, $SD = 14.43$, control group: $M = 46.88\%$, $SD = 38.82$, $p = .019$) to scheduled exercise sessions in patients with schizophrenia in the autonomy-focused setting. In other studies where participants were encouraged to utilise the MCII training repeatedly on their own throughout the study period (both in writing and mentally), there was a positive effect of MCII training on a range of health behaviours, including physical activity (47 min/per week more than the control group after 16 wk from baseline; Marquardt et al., 2017), fruit and vegetable consumption (five servings/per week more than the control group after 24 months from baseline; Stadler et al., 2010), and weight-loss (1.5 kg more than the control group; Stadler et al., 2010). Similarly, studies investigating the day-to-day occurrence of spontaneous MCII-like cognitive patterns found positive associations with goal attainment in multiple life domains (Riddell et al., 2023). Although MCII can be easily incorporated into daily life, whether daily administrations of MCII offer benefits above one-off administration remains empirically unknown.

Sleep goals, in particular, are likely subject to circumstances of the day which might shift the timeline of an individual's sleep schedule (e.g. hosting a big family dinner) and may thus benefit from a more flexible or adaptable intervention program. Repeating MCII on a daily basis could help with the pursuit of dynamic goals by enabling increased goal specificity. Goal specificity reduces ambiguity regarding the goal to be attained, which is found to increase subsequent motivation as progress is made towards achieving the goal (Locke & Latham, 1990, 2019; Wallace & Etkin, 2018). This goal clarity becomes evident when we compare nonspecific (e.g. 'I will go to sleep early from now on') and specific (e.g. 'I will go to sleep at 10 pm tonight') bedtime procrastination goals. Although specificity is important, flexibility must also be taken into consideration (Brandstätter & Bernecker, 2022; Wrosch et al., 2003). Specific but inflexible goals that might arise from a one-off MCII administration (e.g. 'I will go to sleep at 10 pm every night this week') may be overly prescriptive and unfeasible. Failing to attain such goals has implications for well-being and ongoing motives to pursue subsequent goals (Sheldon & Elliot, 1999). Daily administration of MCII may serve to strike a balance between specificity and flexibility. It should be mentioned that daily planning of bedtime does not necessarily mean there will be substantial intra-individual fluctuations in bedtime; people can still end up going to sleep at the same time throughout the week, yet being able to adjust one's bedtime with MCII based on the circumstances of the day allows a potentially realistic approach towards bedtime procrastination goals.

## *The tripartite model of goal striving*

Viewing sleep goals within the context of goal striving invites the consideration of an individual's goal motives for sleeping on time. Derived from self-determination theory (Deci & Ryan, 1985, 2000), Sheldon and Elliot (1999) self-concordance model differentiates between autonomous and controlled goal motives, and suggests that these two forms of goal motives predict alternate outcomes related to self-regulation and goal pursuit. Autonomous motives are evident when goals are pursued for reasons that come from within an individual, and are thus enjoyable, or represent core values and interests. In contrast, reasons for pursuing a goal that are external to the individual (i.e. feeling forced to pursue or feeling shame or regret if not pursued) are classified as controlled motives. A recent meta-analysis of the self-concordance model (Sezer et al., 2024) found autonomous goal motives to be positively and largely related to adaptive goal regulatory variables, goal attainment, and well-being ($.27 < r's < .36$), whereas controlled goal motives were either negatively or not associated with the same outcomes ($-0.12 < r's < .01$). Furthermore, autonomous goal motives were associated with goal attainment *via* adaptive goal regulatory variables, which represent a range of variables that are conducive to goal pursuit.

In the original conceptualisation of the SCM, Sheldon and Elliot (1999) suggested self-concordant goals would be pursued with higher effort. Subsequent research has shown that pursuing such goals is related to many other adaptive forms of goal-regulation, such as goal commitment, goal-related efficacy, and goal reengagement (Downes et al., 2017; Koestner et al., 2012; Ntoumanis et al., 2014). It seems to be the case that people who pursue goals with autonomous motives engage more

with their goals and, hence, they become more likely to attain those goals. Further, the correlational evidence from the goal motives literature indicates that autonomous and controlled motives is related to positive and negative affective states differentially (Sezer et al., 2024). Pursuing autonomous goals is associated with a boost in psychological need satisfaction and well-being when goal is attained. On the other hand, pursuing goals with controlled motives is related to 'dark side' of goal striving, meaning it is associated with higher maladaptive goal-regulation (e.g. goal disengagement), psychological need frustration and ill-being. The type of goal motives predicts affective states independently.

According to Ntoumanis and Sedikides (2018) tripartite model of goal striving, the effectiveness of MCII should be at least partially dependent on a person's goal motives. Specifically, MCII training should be most beneficial for encouraging persistence with attainable goals in individuals with controlled goal motives, as these individuals stand to benefit most from an intervention that bolsters their goal commitment. The MCII process provides a vision with clearly outlined steps as to how the goal could be attained. This clarity is especially helpful for people with controlled motives because it guides the person towards pursuing goals that are unpleasant or less pleasant than other goals to pursue. To contextualise, a person with controlled goal motives might know they should go to sleep on time to feel rested and energetic the next day but choose to procrastinate because watching Netflix or playing games is more fun than going to sleep on time. In sum, by showing the ways that can make the goal pursuit easier through identifying obstacles and how to overcome them, MCII can be more beneficial for people with controlled motives. Initial evidence is supportive of this hypothesis, with studies demonstrating that MCII can mitigate the negative effects of controlled goal motives on goal striving by buffering maladaptive self-regulatory variables (Riddell et al., 2022; Riddell et al., 2024; Riddell et al., 2024). Individuals with autonomous motives for obtaining a good night's sleep are more likely to achieve an adequate amount of sleep and are thus less likely to benefit from intervention (Hagger et al., 2014; Reid & Dautovich, 2021). Clearly, it is important to consider the effects of goal motives when determining when or for whom MCII is most effective.

## *The current study and hypotheses*

In the present superiority trial (Dunn et al., 2018), we aim to build upon existing research on MCII and bedtime procrastination (Valshtein et al., 2020) by investigating the effectiveness of daily versus a one-off application of MCII for reducing bedtime procrastination in the general population. This focus addresses a significant gap in the MCII literature and provides a critical step towards development of an optimised intervention for bedtime procrastination. Further, we will assess how the type of goal motives towards pursuing a bedtime procrastination goal relate to goal attainment and, in turn, to well-being (i.e. positive affect, negative affect). This motivational focus represents another conceptual contribution of this study, as bedtime procrastination goals have so far not been investigated in relation to their underlying goal motives. Finally, we will examine the boundary conditions where MCII and goal motives interact with each other to predict lower bedtime procrastination. We executed a week-long diary study to measure our predictors (i.e. MCII, goal motives), potential mediators

(i.e. adaptive goal-regulatory variables), and outcome variables (i.e. bedtime discrepancy scores, as measured by the difference between intended and actual time for going to sleep, positive affect, and negative affect). We test several specific hypotheses based on the theoretical considerations and previous findings in the literature:

a. H1: Participants who complete MCII daily, compared to once only at the start of the week, will report lower bedtime procrastination levels after a week.
b. H2a: In both MCII conditions, pursuing the bedtime procrastination goal with autonomous goal motives will predict lower bedtime procrastination levels than pursuing with controlled goal motives.
c. H2b: The effect of autonomous goal motives on bedtime procrastination will be mediated by adaptive goal-regulatory variables.
d. H3: Participants with high controlled goal motives will reduce their bedtime procrastination levels more in the daily MCII condition, compared to the single MCII condition.
e. H4a: Attaining bedtime goal will be associated with higher positive affect the next day.
f. H4b: Attaining bedtime goal will be associated with lower negative affect the next day.

## Methods

### *Participants and sample size justifications*

Participants were selected from the general public in the UK and aged 18 years or older. We assessed eligibility criteria prior to the main study *via* an initial survey in which we sampled a larger cohort that answered diverse health-related questions of which sleep was one option. Inclusion criteria comprised a set of questions that asked participants their intention to improve their sleep health, among other health behaviours (e.g. dietary consumption). Participants who expressed intention to improve their sleep were subsequently presented with a list of sleep hygiene behaviours (e.g. setting a regular bedtime, limiting blue light) and asked which of them they would be willing to use to improve their sleep health over the next 2 weeks. We only recruited participants who indicated going to sleep at a regular time as one consideration for them because MCII helps turn wishes into action, thus it is essential for participants to have such bedtime wishes as a starting point. Exclusion criteria encompassed individuals who reported a sleep condition affecting their sleep (e.g. insomnia), those employed in shift work, individuals taking medication that impacts sleep (e.g. beta-blockers), or those responsible for overnight care of dependents (e.g. children under 3 years old or the elderly). Further, we conducted the main analysis with participants who provided at least five days of diary data.

We aimed to recruit a total of 250 participants based on statistical simulations of multilevel models conducted by Arend and Schäfer (2019) and expert recommendations outlined by Gabriel et al. (2019). Arend and Schäfer's simulations showed that 80% power can be achieved to detect effect sizes of .10 for level 1, .23 for level 2, and .32 for cross-level interactions with a dataset comprising 200 participants

providing seven days of diary data. Additionally, Gabriel et al. (2019) conducted a comprehensive review of 107 experience sampling method studies and recommended a minimum of 83 participants for the level 2 sample size and at least 835 observations for the level 1 sample size to ensure robust statistical power. Thus, we consider that a sample of 250 participants, contributing 1750 daily responses, is appropriate to detect the smallest effect size of potential interest (i.e. $r$ = .23; Sezer et al., 2024). Assuming a 15–20% attrition rate, we sampled 303 participants to end up with 250 participants at level 2.

We recruited participants *via* the online recruitment platform Prolific. As we expect study recruitment to be rapid in Prolific, we created five separate baseline surveys, each of which was open for two hours consecutively between 10 am and 8 pm, with only 60 participants being able to complete surveys within each 2-h block. In so doing, we aimed to minimise potential bias of participant characteristics (e.g. recruiting mainly early-risers). If we did not reach 120 participants in the first two blocks, we increased the quota by the missing amount in the third slot. Similar arrangements were done for the final block, depending on the recruitment in the fourth block.

## Measures

### Between-person

***Demographics.*** We obtained information on participants' age, gender, ethnicity, marital status, education level, employment status, housing situation (e.g. living alone, living with a partner), number of people and children (above three years old) living at home with them, and whether they are working within traditional working hours (i.e. 9–5).

***Goal motives for going to sleep on time.*** We assessed participants' goal motives for going to sleep on time using the 20-item Comprehensive Relative Autonomy Index (Sheldon et al., 2017). The measure comprises six distinct subscales that are aligned with the six regulation types delineated in self-determination theory. Each of these regulation types is assessed with four items. Participants were asked to rate their agreement with each statement using a scale ranging from 1 (*does not correspond at all*) to 7 (*corresponds completely*). We averaged the scores from the intrinsic (e.g. 'because it is a pleasure to go to sleep on time'), identified (e.g. 'because I strongly value going to sleep on time'), and positively introjected (e.g. 'because I want to feel proud of myself') regulation subscales to derive an autonomous goal motives score. Similarly, we averaged scores from the negatively introjected (e.g. 'because I would feel guilty if I didn't go to sleep on time') and external (e.g. 'because I don't have any choice but to go to sleep on time') regulation subscales to calculate a controlled goal motives score. We excluded the amotivation subscale (e.g. 'Honestly, I don't know why I go to sleep on time') when calculating the goal motives scores, as this subscale is incongruent with goal-oriented behaviours (Ryan & Deci, 2000). Sheldon et al. (2017) have provided reliability and validity evidence of the scale across diverse samples (i.e. Americans and Russians) and various behavioural domains (e.g. attending classes, pursuing majors).

***Chronotype.*** We used the Composite Scale of Morningness (Smith et al., 1989) to assess the chronotype of the participants. The scale consists of 13 items that examine the time participants wake up and go to bed, their perception of themselves as a morning or evening person, and their general alertness and tiredness in the morning. Example items include 'Considering only your own 'feeling best' rhythm, at what time would you go to bed if you were entirely free to plan your evening?' and 'Assuming normal circumstance, how easy do you find getting up in the morning?'. The items are rated on a 4- or 5-point scale. Following Smith et al. (1989), the scores were summed to obtain the morningness score which can range from 13 (extreme eveningness) to 55 (extreme morningness).

***Sleep functioning.*** We evaluated participants' sleep functioning over the past week through a three-item self-report measure. This measure encompasses an item that targets participants' average sleep duration per 24-h cycle for the past week (i.e. 'Over the past week, on average, how many hours of sleep per night have you slept?') and another item that assesses sleep recovery (i.e. 'How many hours of sleep per night do you need to feel rested and recovered the following day?'). Participants provided their responses for these two items using a 0 to 24 scale (i.e. number of hours). Additionally, participants assessed their perceived sleep quality over the past week using a single-item question (i.e. 'Over the past week, on average, how would you rate the quality of your sleep per night?'), rated on a 0 (*completely inadequate*) to 10 (*outstanding*) scale with one-point intervals.

### *Within-person*

***Daily goal and sleep descriptives.*** Participants established their daily sleep goals each evening. They set their sleep goal by responding to the query, 'What time do you plan to be in bed with the goal to fall asleep, that is, physically lying down in your bed with lights out?' and by completing the statement 'I plan to be in bed with the aim to fall asleep by _____ pm/am' Subsequently, participants indicated with a 'yes' or 'no' response whether they anticipate experiencing physical or psychological deprivation the following day if they go to sleep later than what is documented in their planned goal. As an examination of integrity, we compared participants' evening survey completion time to their designated bedtime on nights they achieved their goal versus failed to achieve their goal. This way we can check whether or not participants filled out their surveys closer to their bedtime on nights they attained their bedtime procrastination goals.

Each morning, participants indicated the time they went to bed the previous night, as well as the approximate time they woke up that morning. We calculated the bedtime discrepancy score by determining the time difference between the intended bedtime (i.e. sleep goal) and the actual time for going to sleep. If participants deviated from their planned bedtime by going to sleep later than intended, we investigated the underlying reasons for this delay. We prompted participants to provide their reasons for bedtime delay in an open-ended text box. Two analysts independently coded reasons for bedtime delay as valid, when both analysts agree participants had no reasonable alternative but to delay their bedtime. We provided inter-rater reliability

(Cohen's kappa) as a measure of congruence, along with the reasons on Open Science Framework (https://osf.io/rmzbc/). We resolved disagreements through discussion. We excluded cases where participants have a valid reason to go to bed later than intended from further analysis. This approach allowed us to concentrate on instances of procrastination that align with its definition. In short, we operationalised bedtime procrastination as the bedtime discrepancy score between intended and actual bedtime for cases where participants were expecting to experience physical or psychological deprivation (i.e. those who answered 'yes') and had no valid reason to delay their bedtime.

We computed the duration of sleep (i.e. sleep quantity) by measuring the time span between lying in bed to sleep and waking up. Participants also evaluated the quality of their sleep for the preceding night using a scale that ranges from 0 (*completely inadequate*) to 10 (*outstanding*) with one-point intervals. Participants were asked to report how many times they woke up for at least 5 min during the night as a measure of sleep disruption. Participants answered these items in the morning survey. Finally, we asked participants to report whether they plan to work on that day.

***Adaptive goal-regulatory variables.*** Participants answered three items about their goal effort ('How much effort will you exert towards your goal of going to sleep on time?') and goal commitment ('How committed are you to getting to bed on time tonight?'). Participants provided their answers for these items on a scale ranging from 1 (*not at all*) to 7 (*very much so*). We chose these variables because they were found to be the most frequently investigated variables in the self-concordance literature (Sezer et al., 2024). This assessment was included in the evening survey package.

***Daily affect.*** We employed the short version of the Positive and Negative Affect Schedule (PANAS-SF; Thompson, 2007) to evaluate participants' daily affect levels. The PANAS scale consists of 10 items, with five items assessing positive affectual states and five items evaluating negative affectual states. Participants rated the extent to which they experienced each type of positive and negative affect on a scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*) for that day. We derived a composite score of positive affect (e.g. inspired, active) and negative affect (e.g. nervous, alert) by averaging the respective item scores. The PANAS scale was administered as part of the morning survey package.

## Procedure

Participants completed a consent form, a demographics questionnaire, and baseline assessments related to goal motives for going to sleep on time and sleep functioning on a Sunday. Next, we provided participants with information about the benefits of sleeping well according to recommended guidelines and then randomly assigned them to either daily MCII or single MCII groups. The allocation of participants into the groups was conducted by using the built-in randomisation feature of our survey software (i.e. Qualtrics). Condition assignment was masked for both participants and researchers. Starting from Monday evening and for the next seven days, participants

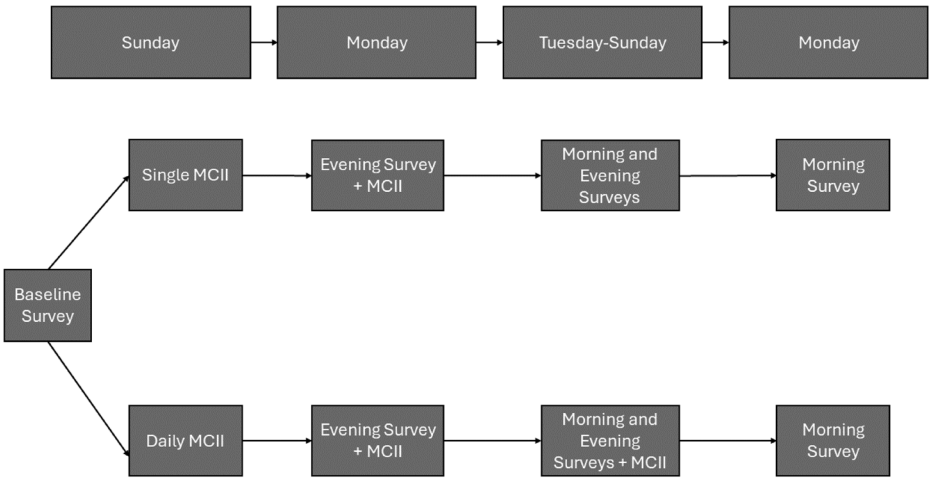


**Figure 1.** Visual depiction of the study timeline.

received two surveys daily: an evening survey at 3 pm and a morning survey at 5 am (please see Figure 1 for the timeline). The evening survey, administered between 3 pm and 8 pm, encompassed measures about participants' daily goals, goal-related items, and their MCII training (single vs. daily, please see MCII Training below). The morning survey aimed to capture information about participants' sleep patterns from the previous night and the reasons behind any bedtime delays (if applicable), as well as the affect measure. Participants had the flexibility to complete the morning survey anytime between 5 am and 12 pm. At the end of the week-long data collection period, we used a single-item manipulation check to ascertain if participants in the single MCII condition completed MCII more than once during the study period. We provided participants with a debriefing, explaining the study's purpose, and thanked them for their participation.

## *MCII Training*

We have designed our MCII training based on published examples (e.g. Adriaanse et al., 2010; Riddell et al., 2023) and online materials (woopmylife.org). On Monday evening, participants in the single MCII condition engaged in a structured process. First, they began by restating their weekly bedtime goal, such as aiming to go to sleep at 11 pm Second, participants vividly imagined achieving this goal and explored the most positive outcomes they associated with this accomplishment (e.g. feeling rested or being more energetic next day). Third, they engaged in mentally contrasting this positive vision with the current reality of their situation (i.e. desire to watch TV series) to identify the obstacles that stood between them and their goal. Fourth, participants developed implementation intentions by specifying precise plans for how they will act if faced with the temptation to engage in their current activity (e.g. 'if I want to watch TV series, I will watch until 10.00 pm and then get ready for going to sleep'). To facilitate this four-step process, participants were provided with instructional videos for each stage. They were also prompted to record their experiences

and responses in text boxes at each step of the MCII training and these responses were used to check compliance with the intervention.

Participants in the daily MCII condition went through the same steps of the MCII training, but with a couple of differences. Firstly, participants in the daily MCII condition personalised their goals each night. During the evening survey, we asked participants in this group to set a bedtime goal for the night (e.g. 10 pm on Tuesday, 11:30 pm on Saturday). This way they had the chance to consider their schedules or plans for the night and set their bedtime goal accordingly. Secondly, participants in the daily MCII condition completed the MCII training every evening for the next seven days (instead of doing a single MCII training at the beginning of the 7-day study period). In the daily MCII training, they were asked to think the potential obstacles relevant for that night and populate implementation intention plans that target those obstacles. For example, if a participant has a date with a romantic partner on Friday night, they might choose to defer their bedtime an hour than their usual bedtime. We presented the training instructions, which were developed based on the guide on woopmylife.org, for both groups in the Supplementary Material.

## *Statistical analyses*

We plan to use the 'lavaan' (Rosseel, 2012) package within R (R Core Team, 2021) to conduct a multilevel structural equation modelling (MSEM; Preacher et al., 2010) with maximum likelihood estimation. Daily responses (within-person) were nested within participants (between-person). The within-person variables were adaptive goal-regulatory variables, bedtime discrepancy score, and positive affect. The between-person variables were autonomous goal motives, controlled goal motives, and MCII training. We will use the Root Mean Square Error of Approximation (RMSEA), the Confirmatory Fit Index (CFI) and the Standardized Root Mean Square Residual (SRMR) to assess model fit. We will also report the chi-square ($\chi^2$) test results, although it is expected to be statistically significant with the planned sample size. The traditional cut-off points for a good fit are values below 0.08 for RMSEA, above 0.95 for CFI, and below 0.08 for SRMR (Hu and Bentler, 1999). Hypothesis tests that included a between-person variable (H1, H2, H3) examined both between- and within-person variance. We tested H4 at the within-person level only.

Controlling for baseline chronotype and sleep functioning metrics (duration, recovery, and quality), we modelled the hypothesised effects and the interaction by testing main effects of MCII training (H1) and autonomous goal motives at the between-person level (H2a). We hypothesised a mediation effect of adaptive goal-regulatory variables (level 1 mediator) in the relation between autonomous goal motives (level 2 predictor) and the bedtime discrepancy score (H2b). We will compare a full mediation model and a partial mediation model to examine the mediator role of adaptive goal-regulatory variables in more detail. This comparison will be tested with a likelihood ratio test. Finally, we entered the interaction between MCII training and controlled goal motives at the between-person level (H3). At the within-person level, we tested the association between adaptive goal-regulatory variables and bedtime discrepancy score. Further, we examined the association of bedtime discrepancy score with positive affect (H4a) and negative affect (H4b). We controlled for sleep quantity and sleep quality on the

previous night when testing the within-person associations. A visual depiction of the conceptual model is provided in the Supplementary Material.

We conducted sensitivity analyses to examine the reliability of our results. First, we assessed in/consistency in study results relative to the number of diaries participants completed. Specifically, we compared the effects between participants who completed less than three days, 4–5 days, and 6–7 days of data. Second, we re-ran the primary analyses including those people in the single MCII condition who indicated they used it more than once during the testing period to see if and how the results differ.

## Results

The data files and analysis codes can be found in the OSF page (https://osf.io/rmzbc/). We screened 1000 participants in an initial survey, with 630 (63%) considered eligible for participation in the main study. We invited eligible participants to join our study and stopped inviting once we recruited 303 (out of 415 invitations) participants. We removed six participants because they completed the demographic questions of the baseline survey only. We distributed daily surveys to the remaining 297 participants, with roughly equivalent randomisation to the single MCII ($n = 148$) and multiple MCII ($n = 149$) experimental conditions. Of these 297 participants, the proportion of back-to-back evening and morning daily surveys completed ranged from 2% (those who completed only one day) to 58% (those who completed all seven days) of the sample. We excluded 16 participants from the analysis for the following reasons: no bedtime goal for the week because of an incomplete first evening survey ($n = 11$ from the single MCII group); no bedtime discrepancy scores because they failed to complete back-to-back evening and morning surveys ($n = 2$ from the single MCII group and $n = 2$ from the daily MCII group); and invalid MCII information (i.e. 'no' or 'none' in all MCII steps, $n = 1$ participant from the daily MCII group). The final sample size for data analysis was 281 (see Figure 2 for full breakdown).

Participants described themselves as predominantly male (62%), white ethnicity (90%), either married or in a domestic partnership (64%), tertiary educated (43% bachelor's degree), employed full-time (81%), and worked traditional hours (9 am to 5 pm; 95%). Regarding their housing situation, most participants reported they live with their partner/family (79%), where there were between 2–3 people in the household ($M = 2.65$, $SD = 1.25$) and typically included 1 child ($M = 0.69$, $SD = 1.02$). Participants indicated that they required between 6 and 10 h of sleep to feel rested ($M = 7.72$, $SD = 0.85$), and slept between 5 and 9 h on average over the past week ($M = 6.60$, $SD = 1.04$), with a medium level sleep quality ($M = 2.90$, $SD = 0.83$; see Table 1 for the comparison of information for each group). During the study period, participants reported waking up in the middle of the night one time on average ($M = 1.16$, $SD = 1.33$).

We were able to compute bedtime discrepancy scores for 1683 out of 1967 daily surveys. Participants provided 418 reasons for their instances of bedtime delays across these 1683 cases. We coded 102 reasons as valid reasons for delaying bedtime. Examples of valid reasons included 'feeling ill', 'noisy neighbours', and 'picking up somebody from the airport'. Examples of invalid reasons included 'scrolling Tiktok',

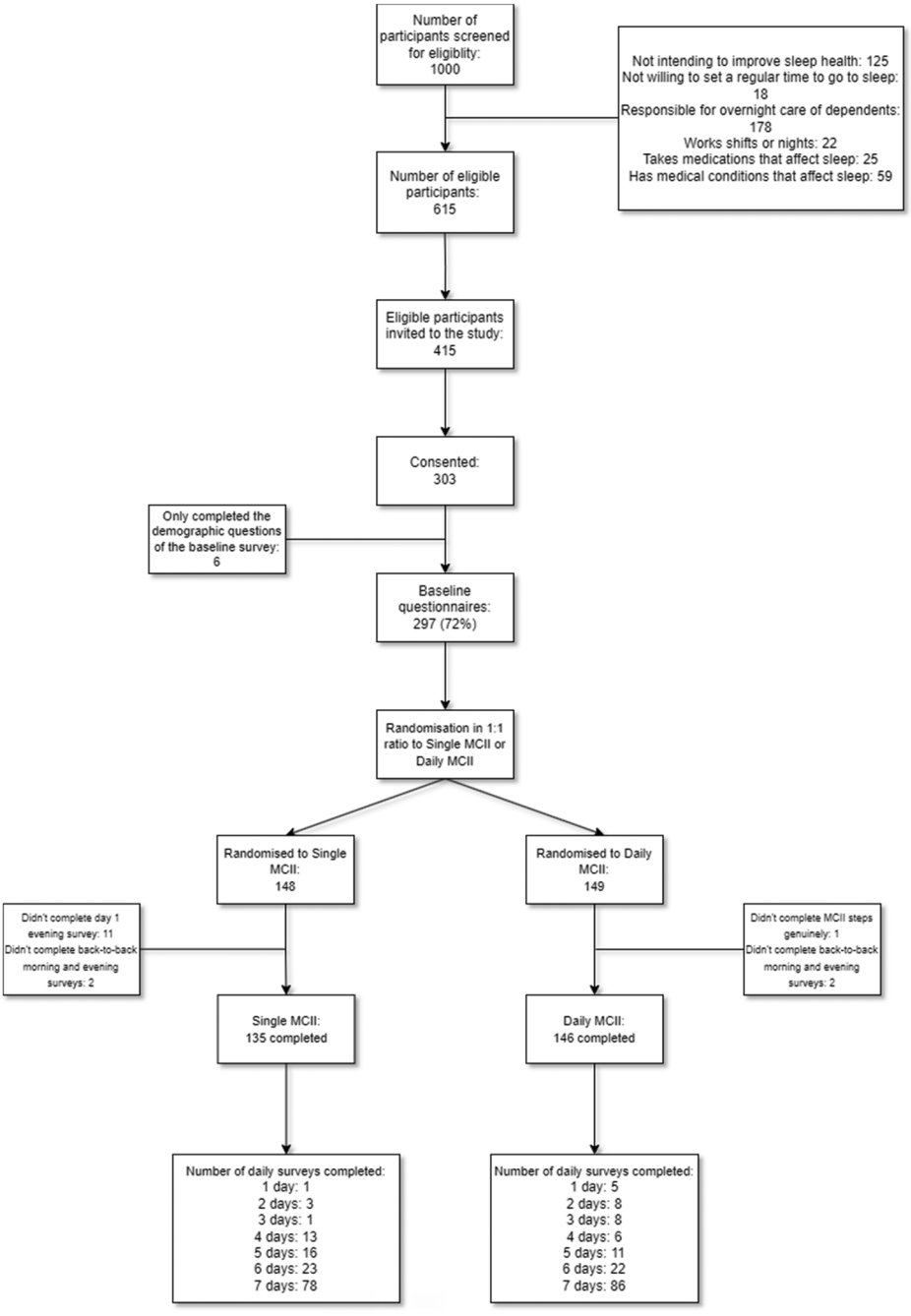


**Figure 2.** Participant flow diagram.

'watching a movie with partner', and 'losing track of time'. The interrater reliability between the two raters was 86% (see Supplementary Material). The total number of cases that participants either did not expect to be physically or psychologically deprived the next day or had a valid reason to delay their bedtime (or a combination of both) was 857. Thus, we excluded these occurrences from our primary analysis. In

**Table 1.** Comparison of demographic variables between single MCII and daily MCII groups.

| | Single MCII ($N = 135$) | Daily MCII ($N = 146$) |
|---|---|---|
| Age | 42.65 (11.04) | 42.81 (11.25) |
| Gender | | |
| Male | 87 (64%) | 87 (60%) |
| Female | 47 (35%) | 59 (40%) |
| Prefer not to say | 1 (1%) | 0 (0%) |
| Ethnicity | | |
| White | 121 (90%) | 131 (90%) |
| Asian or Asian British | 7 (5%) | 9 (6%) |
| Black, Black British, Caribbean or African | 3 (2%) | 3 2% |
| Mixed or multiple ethnic groups | 3 (2%) | 1% (2) |
| Other ethnic groups | 1 (1%) | 1% (1) |
| Marital status | | |
| Married or domestic partnership | 87 (64%) | 93 (64%) |
| Single | 37 (27%) | 35 (24%) |
| Widowed | 2 (1%) | 1 (1%) |
| Divorced or separated | 6 (4%) | 13 (9%) |
| Other | 3 (2%) | 4 (3%) |
| Education | | |
| Primary school | 0 (0%) | 1 (1%) |
| Secondary school | 24 (18%) | 25 (17%) |
| Vocational education | 26 (19%) | 25 (17%) |
| Bachelor's degree | 55 (41%) | 66 (45%) |
| Master's or Doctoral degree | 30 (22%) | 29 (20%) |
| Employment | | |
| Employed full-time | 112 (83%) | 115 (79%) |
| Employed part-time | 21 (16%) | 31 (21%) |
| Student | 1 (1%) | 0 (0%) |
| Retired | 1 (1%) | 0 (0%) |
| Traditional hours | | |
| Yes | 129 (96%) | 138 (95%) |
| No | 5 (4%) | 8 (5%) |
| I do not have a job | 1 (1%) | 0 (0%) |
| Housing | | |
| I live with my partner/family | 104 (77%) | 119 (82%) |
| I live alone | 23 (17%) | 21 (14%) |
| I live in a shared house (e.g. roommates) | 8 (6%) | 6 (4%) |
| Number of people living at home | 2.68 (1.27) | 2.63 (1.24) |
| Number of children living at home | 0.77 (1.04) | 0.62 (1.01) |
| Sleep functioning | | |
| Baseline hours of sleep needed to feel rested | 7.70 (0.76) | 7.73 (0.93) |
| Baseline hours slept on average | 6.64 (0.97) | 6.57 (1.10) |
| Baseline sleep quality | 2.96 (0.81) | 2.85 (0.85) |

the remaining 826 cases, participants expected to being deprived and had no valid reason to delay their bedtime, therefore, fitted with our operationalisation. In 391 of these cases, participants went to bed as intended and 436 cases involved bedtime delay. For our hypothesis testing, we ran the analysis with this subsample who went to bed on time or delayed their bedtime, where they expected to be deprived the next day, had no valid reason to delay their bedtime, and completed five days of back-to-back daily surveys ($n = 779$). We refer readers to the Supplementary Material for the results of exploratory analyses: one where we included only cases with delayed bedtimes, and another where we replaced bedtime discrepancy scores with a binary variable indicating the presence or absence of bedtime procrastination. Finally, we calculated the average bedtime discrepancy scores by participants, MCII condition,

and day of the week for this subsample. Across participants, the average bedtime discrepancy score was 26.95 min ($SD = 43.91$), with daily estimates ranging from 21.56 min ($SD = 40.98$) to 30.56 min ($SD = 47.71$; see Table 2). The average bedtime discrepancy score of the single MCII condition was 36.14 min ($SD = 63.37$) and 20.02 min ($SD = 37.69$) for the daily MCII condition.

## *Hypothesis testing analyses*

We deviated from our preregistered statistical analysis plan in two ways because we encountered model convergence issues. First, we pivoted to a Bayesian estimation framework for computational convenience rather than the underlying philosophical positioning (Levy & McNeish, 2023). Second, we switched from the 'lavaan' package (Rosseel, 2012) within R (R Core Team, 2021) to *Mplus* software because it permits latent variable interactions that outperform maximum-likelihood estimation approaches (Asparouhov & Muthén, 2021). One disadvantage of this pivot is that model-data fit statistic (e.g. posterior predictive p-value, deviance information criterion) are currently unavailable when including latent variable interactions. We executed Bayesian MSEM using *Mplus* 8.11 (Muthén & Muthén, 2017) with default, non-informative priors and a minimum of 10,000 iterations for each of the Markov chain Monte Carlo chains when the potential scale reduction convergence criterion is employed. We saved estimates from every 10$^{th}$ iteration of draws for the posterior distribution, where our updated belief about the parameters (the posterior) is based on how well those parameters explain the data (the likelihood) and what we originally thought before seeing the data (the prior). The Bayesian posterior distribution is roughly equivalent to estimates obtained *via* maximum likelihood estimation when non-informative priors are used as prior beliefs (Gelman et al., 2014).

The primary analytical model converged well, with potential scale reduction values stable and below 1.1 after 800 iterations. Full details of the outputs of the main analysis as well as our sensitivity analyses are provided in Table 3; a visual depiction of the core findings is provided in Figure 3. Supporting hypothesis 1, participants who completed MCII daily, compared to once only at the start of the week, reported procrastinating less before bedtime across the study period, on average, by around 19 mins ($b = -16.11$, 95% credibility interval [CI] = −28.01, −4.25). Supporting both elements of hypothesis 4, the total time of their bedtime procrastination delay was associated positively associated with negative affect ($b = 0.006$, 95% CI = 0.003, 0.009)

**Table 2.** Means and standard deviations of bedtime discrepancy scores by day of the week.

| | Total sample | | | Single MCII | | | Daily MCII | | |
|---|---|---|---|---|---|---|---|---|---|
| Day of the week | Mean (min) | SD | # of BP cases | Mean (min) | SD | # of BP cases | Mean (min) | SD | # of BP cases |
| Monday | 29.09 | 58.61 | 117 | 36.31 | 71.17 | 59 | 21.74 | 41.57 | 58 |
| Tuesday | 23.55 | 45.95 | 122 | 36.02 | 60.92 | 59 | 11.87 | 19.04 | 63 |
| Wednesday | 24.90 | 44.71 | 129 | 35.10 | 57.62 | 61 | 15.75 | 25.79 | 68 |
| Thursday | 21.56 | 40.98 | 120 | 26.94 | 51.53 | 54 | 17.15 | 29.42 | 66 |
| Friday | 24.46 | 44.43 | 74 | 29.31 | 46.54 | 29 | 21.33 | 43.27 | 45 |
| Saturday | 28.34 | 40.74 | 73 | 49.83 | 52.00 | 30 | 13.35 | 20.44 | 43 |
| Sunday | 30.56 | 47.71 | 111 | 37.26 | 61.71 | 43 | 26.32 | 36.09 | 68 |

*Note.* BP = Bedtime procrastination, SD = Standard deviation, min = minutes.

and inversely related with positive affect ($b = -0.012$, 95% CI = −0.015, −0.008) the following morning. Our expectations regarding hypotheses 2 were unsupported. Although controlled goal motives ($b = 13.92$, 95% CI = 1.05, 26.53) were related to higher bedtime procrastination, the association between bedtime procrastination and autonomous goal motives ($b = 2.60$, 95% CI = −6.75, 12.04) was incompatible with a meaningful effect. Similarly, the mediation effect of adaptive goal-regulatory variables from autonomous goal motives to bedtime procrastination ($b = -0.70$, 95% CI = −2.77, 0.83) and the latent interaction between experimental condition and controlled goal motives ($b = -14.05$, 95% CI = −28.39, 0.08) were inconsequential.

## *Sensitivity analyses*

The results of our sensitivity analyses are presented in Table 3. We observed model convergence issues when we ran the analysis with a subsample of participants who completed less than three days of full daily survey completion ($N_{obs}$ = 70). We did not observe a meaningful effect to support our hypotheses when we conducted the analysis with participants who completed 4 or 5 days of diary data ($N_{obs}$ = 132). The results were consistent with the main sample when we only included participants who completed 6–7 days of diary data ($N_{obs}$ = 691), except now the association between adaptive goal-regulatory variables and bedtime procrastination ($\Delta b = -3.06$, $b = -7.29$, 95% CI = −13.62, −0.88) and the interaction between MCII condition and controlled goal motives ($\Delta b = -2.21$, $b = -16.26$, 95% CI = −28.65, −5.07) excluded zero as a plausible estimate. We also re-ran the analyses retaining only those participants in the single MCII group who indicated in the final morning survey that they used MCII only once within the data collection period. In total, 118 of 135 participants in the single MCII group completed this survey, with 37 participants (31%) reporting

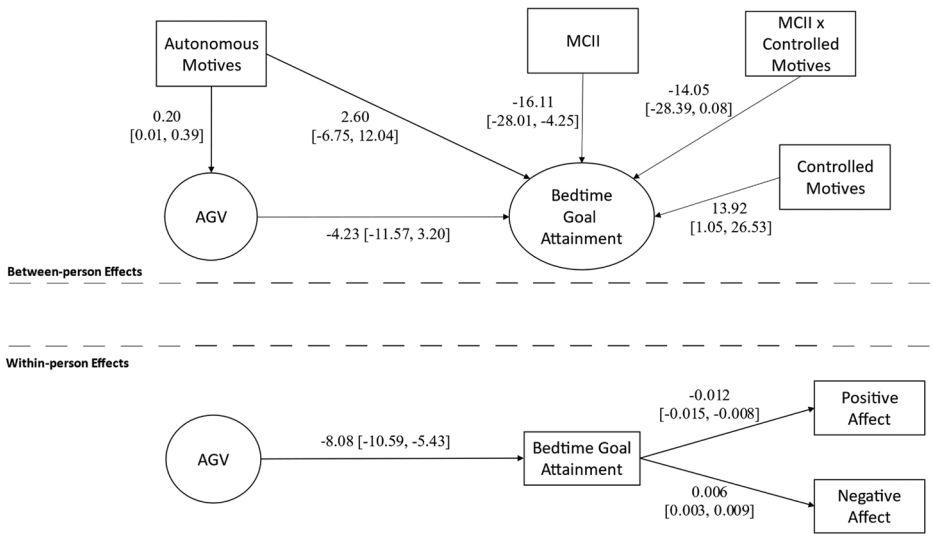


**Figure 3.** Bayesian multilevel structural equation model.
*Note.* AGV = Adaptive goal-regulatory variables, MCII = Mental contrasting with implementation intentions. For clarity, we present only latent factors. All parameters are unstandardised. 95% credibility intervals are reported in square brackets.

**Table 3.** Unstandardised estimates of Bayesian multilevel structural equation model results.

| Multilevel paths | Main analysis | Sensitivity analyses | | |
|---|---|---|---|---|
| | | 4–5 days | 6–7 days | Once MCII |
| *Within-person effects* | $N_{obs}$ = 768 | $N_{obs}$ = 132 | $N_{obs}$ = 691 | $N_{obs}$ = 600 |
| AGV → BD | **−8.08 [−10.59, −5.43]** | **−6.68 [−13.36, −0.19]** | **−7.63 [−10.33, −4.84]** | **−6.26 [−9.13, −3.34]** |
| Sleep Duration$^{t-1}$ → BD | **−0.18 [−0.23, −0.14]** | **−0.18 [−0.31, −0.05]** | **−0.19 [−0.23, −0.15]** | **−0.19 [−0.24, −0.15]** |
| Sleep Quality $^{t-1}$ → BD | **−7.54 [−10.68, −4.78]** | −2.39 [−12.47, 8.26] | **−6.61 [−9.68, −3.62]** | **−3.32 [−6.48, −0.17]** |
| BD → Positive Affect | **−0.012 [−0.015, −0.008]** | −0.01 [−0.02, 0.01] | **−0.009 [−0.013, −0.006]** | **−0.004 [−0.008, 0.000]** |
| BD → Negative Affect | **0.006 [0.003, 0.009]** | 0.009 [−0.002, 0.021] | **0.006 [0.002, 0.009]** | **0.004 [0.001, 0.008]** |
| $R^2$ (BD) | 31% | 29% | 29% | 27% |
| $R^2$ (Positive Affect) | 13% | 7% | 9% | 2% |
| $R^2$ (Negative Affect) | 4% | 7% | 3% | 2% |
| *Between-person Effects* | *n* = 193 | *n* = 36 | *n* = 172 | *n* = 154 |
| AGM → AGV | **0.20 [0.01, 0.39]** | −0.22 [−1.41, 1.17] | **0.21 [0.04, 0.42]** | 0.18 [−0.04, 0.39] |
| AGV → BD | −4.23 [−11.57, 3.20] | −4.17 [−49.18, 43.52] | **−7.29 [−13.62, −0.88]** | −4.07 [−9.70, 1.00] |
| MCII Condition → BD | **−16.11 [−28.01, −4.25]** | −37.32 [−94.28, 16.16] | **−12.63 [−22.19, −2.60]** | −13.28 [−28.75, 3.57] |
| AGM → BD | 2.60 [−6.75, 12.04] | −2.50 [−76.06, 67.89] | 2.16 [−5.21, 9.97] | 0.07 [−6.55, 6.36] |
| CGM → BD | **13.92 [1.05, 26.53]** | −1.21 [−63.44, 59.67] | **16.65 [6.57, 26.99]** | **60.15 [36.31, 89.06]** |
| Chronotype → BD | −2.70 [−9.72, 4.00] | −7.64 [−57.84, 43.84] | −1.16 [−6.65, 4.61] | −2.68 [−7.82, 2.19] |
| Sleep Duration → BD | 4.22 [−3.58, 11.86] | −0.93 [−32.06, 30.17] | 6.42 [−0.02, 12.50] | **5.06 [0.45, 9.72]** |
| Sleep Recovery → BD | −5.61 [−12.84, 1.71] | −0.04 [−41.72, 40.54] | −3.10 [−8.85, 3.27] | −2.63 [−7.90, 2.35] |
| Sleep Quality → BD | 6.92 [−1.92, 15.87] | 14.45 [−21.42, 50.56] | 3.27 [−4.36, 10.76] | 2.19 [−3.71, 8.52] |
| MCII x CGM → BD | −14.05 [−28.92, 0.08] | −1.66 [−79.93, 87.32] | **−16.26 [−28.65, −5.07]** | **−58.88 [−86.27, −33.45]** |
| $R^2$ (BD) | 19% | 42% | 32% | 74% |
| $R^2$ (AGV) | 4% | 18% | 4% | 3% |

*Note.* Effects that do not contain zero are indicated in bold. AGM = Autonomous goal motives, AGV = Adaptive goal-regulatory variables, BD = Bedtime discrepancy, CGM = Controlled goal motives, MCII = Mental contrasting with implementation intentions. 95% credibility intervals are reported in square brackets.

that they practiced the MCII training only once (total $N_{obs}$ = 600). The results were consistent with the primary analysis at the within-person level. The interaction between MCII condition and controlled goal motives ($\Delta b = -44.83$, $b = -58.88$, 95% CI = −86.27, −33.45) excluded zero as a plausible estimate at the between-person level.

## Discussion

Bedtime procrastination represents a key threat to maintaining a regular sleep pattern (for a meta-analysis, see Hill et al., 2022). In the present study, we developed a novel method for operationalising daily bedtime procrastination that aligns with its concept definition. In addition, we examined the effectiveness of a simple metacognitive goal striving technique for reducing bedtime procrastination. Extending previous work in this field, we compared the effectiveness of single and daily MCII applications in reducing bedtime procrastination. We found that participants who completed daily MCII reported procrastinating less before bedtime relative to individuals who performed MCII one-off at the start of the study period. Amount of bedtime procrastination was positively associated with negative affect and inversely associated with positive affect the following morning. Our expectation that the differential effectiveness of daily versus one-off MCII application would be most pronounced for participants with controlled goal motives received mixed support. The prediction that adaptive goal-regulation would mediate the link between autonomous goal motives and bedtime discrepancy scores was unsupported.

The difference in bedtime procrastination between daily and one-off MCII was aligned with our expectations. Practising MCII daily allows participants to pursue their bedtime goals flexibly in ways that are sensitive to personal (e.g. desire to achieve 7–8 h of sleep per night) and contextual (e.g. expected disruptions to one's usual routine) dynamics. In essence, completing MCII daily prompts individuals to set their bedtime goals iteratively and relative to the circumstances of a given day, including potential obstacles that could prevent them attaining their bedtime goal. In contrast, single MCII participants set a bedtime for the entire of the week and thought about an obstacle that had to be relevant for the whole week, which assumes that their personal and contextual circumstances would essentially be the same throughout the entire forecasting period. Completing MCII daily means participants focus on obstacles that would be relevant only on the same day, which presumably makes it easier to remember them and allows one to be more specific with their implementation intentions plans, compared to recalling obstacles chosen several days prior (Chen et al., 2015). This distinction between the two groups is important, as the level of specificity of the implementation intentions plans is a better predictor of behaviour than the number of plans one simultaneously formulates (De Vet et al., 2011). Although participants in the daily MCII condition constructed up to seven times more implementation intention plans than single MCII participants, these plans were created daily (rather than at the same time) and were valid for the day, which did not cause overburden on the participants while allowing participants being specific with their plans.

One-off administration of MCII may be inadequate for capturing how a person's focal goal relates to various other personal goals and provides limited scope for a person to adapt their goal striving in the face of a dynamic environment (Fishbach et al., 2024;

Kung & Scholer, 2021). People usually pursue multiple goals at the same time (Kruglanski et al., 2018), which might also compete with each other. For instance, the goal of going to sleep on time might compete with the goal of being together with family and friends at special occasions (e.g. birthday dinners). People are less likely to prevent themselves from responding to the demands of competing goals, unless they are highly committed to fulfilling their main goals (Shah et al., 2002). Practicing MCII daily may strengthen commitment to one's bedtime goal and help protect against acute distractions from competing goals that are likely to emerge within a more forecastable time period (Kappes & Oettingen, 2014), as well as facilitate the adoption of complementary strategies that enable multiple goals to be accommodated harmoniously (Riddell et al., 2023). These advantages of daily MCII foreshadow a larger issue, namely that single applications of MCII inherently provide little to no room for flexibility. For example, in our study, one-off applications of MCII required participants to forecast the same bedtime for the entire week. Overly restrictive goal pursuit is known to be detrimental to psychological health (van Lankveld et al., 2011) and overly prescriptive or inflexible goal setting can undermine goal attainment (Ntoumanis et al., 2014). Considering single MCII is the modus operandi among previous research (Wang et al., 2021), daily MCII application offers unique features that might optimise pursuit of personal goals.

Regardless of the MCII condition, we found that daily fluctuations in bedtime procrastination had flow on effects for positive and negative affect. As expected, participants reported higher positive affect and lower negative affect when they procrastinated less, relative to their own average. Put another way, participant's affect was improved on days when they attained their goal of reducing bedtime procrastination. These associations align with past evidence for the link between goal progress/attainment and positive indicators of well-being. For example, in their meta-analysis of 108 samples, Klug and Maier (2015) found that both goal progress ($r$ = .45, %95 CI = .40, .50) and attainment ($r$ = .38, %95 CI = .32, .44) were positively associated with subjective well-being. Our findings contribute to the growing body of evidence on the negative association between bedtime procrastination and positive indicators of well-being (e.g. emotional well-being; Dardara & Al-Makhalid, 2021). Although previous research has consistently investigated how bedtime procrastination is associated with negative indicators of well-being, such as depression (Cui et al., 2021; Guo et al., 2020), anxiety (Chung et al., 2020; Geng et al., 2021), and negative affect (Sirois et al., 2019), fewer studies have examined the magnitude of associations between bedtime procrastination and positive indicators of well-being. Notably, previous work examining bedtime procrastination and positive affect has relied on cross-sectional designs, where both bedtime procrastination and positive affect were measured concurrently (Rehman et al., 2023; Sirois et al., 2019). When assessed on a day-to-day basis, we demonstrated a negative within-person association between bedtime procrastination and positive affect, suggesting that daily magnitude of bedtime procrastination is inversely associated with positive affect. In the present study, participants may have reported higher positive affect because reductions in the discrepancy between their intended and actual bedtime led them to feel rested and refreshed the next day (Steptoe et al., 2008). Equally, this finding is in line with the wider sleep literature, indicating that attaining regular and sufficient sleep is beneficial for mental well-being (Castiglione-Fontanellaz et al., 2023; Scott et al., 2021).

Our secondary expectations regarding associations between goal motives and bedtime procrastination were unsupported. Pursuing a bedtime procrastination goal with autonomous goal motives would mean individuals enjoy and/or value making progress (e.g. preparing oneself for the sleep by starting their bedtime routine) and eventually attaining their goal of going to sleep on time (i.e. being in bed at their intended bedtime with lights switched off). One potential explanation for our finding regarding an absence of association between autonomous goal motives and bedtime discrepancy scores could be that the goal of going to sleep on time does not inherently have highly autonomous motivation features. Sleep is primarily a biological need (Freiberg, 2020), rather than an activity we choose for enjoyment or personal fulfillment. In other words, our bodies require sleep for various physiological and cognitive functions, regardless of our personal desires or values. Thus, even for individuals with low autonomous goal motives for going to sleep on time, there is only so much bedtime procrastination they can engage in before they must go to sleep, thus placing an upper limit on the amount of variation in bedtime discrepancy values between individuals with low and high autonomous motives for going to sleep on time.

Regarding the absence of a credible indirect effect of autonomous motives on bedtime procrastination *via* goal-regulatory strategies, we suggest that even for participants who valued going to sleep more or less at the same time, the regulation strategies involving effort and commitment may not have been the most effective for minimising bedtime procrastination. Exerting effort and goal commitment were examined in the current study because they are the two strategies most commonly investigated in the wider goal striving literature; however, there may be a mismatch between the level at which these strategies are effective and the level at which goal motives are measured. Although the conscious exertion of effort and commitment are certainly relevant to many goals (e.g. winning a cycling race; Riddell et al., 2024), there is also evidence to suggest that for goals that require protracted or ongoing control, strategies that minimise the effort needed for goal pursuit may be more effective (Werner et al., 2016; Werner & Milyavskaya, 2019). For the goal of regularly going to sleep on time, it is easy to imagine that if a person actively needed to invest a high level of effort to attain their bedtime goal every night, they would rapidly exceed their goal-regulatory capacity and lapse in their goal pursuit (e.g. Inzlicht et al., 2014). Effort and commitment as goal-regulation strategies predicted bedtime procrastination at the within-person level in the current study, indicating that on days when participants were committed and prepared to exert effort into their bedtime goals, they were more likely to reduce their bedtime procrastination, but this association was inconsequential at the between-person level. Examination of the daily reasons given for sleep delay in the current study suggests that obstacles to attaining sleep goals change from day-to-day. On occasions when individuals face substantial barriers to attaining their bedtime goal, being committed and exerting effort may be necessary; however, on average across the week, consistently effortful modes of regulation may be ineffectual. We suggest two potential avenues for improving the fit between goal motives and goal-regulatory strategies related to sleep behaviour in future work. First, researchers should investigate associations between goal motives and chronic regulation strategies that may be more relevant

at the between-person level, such as the use of routines or establishment of bedtime habits, that is, regulation strategies that reflect a person's typical behaviour. Second, researchers should examine how day-to-day fluctuations in goal motives relate to acute regulation strategies necessary for overcoming immediate obstacles to goal pursuit at the within-person level, such as exerting effort or maintaining commitment, that is, regulation strategies that reflect 'in-the-moment' behaviour.

The hypothesised interaction between MCII and controlled goal motives received mixed support. Although the interaction effect was not meaningful in the primary analysis, it was credible in our sensitivity analyses that included only participants who adhered to the intervention protocol, that is, individuals who completed MCII training for at least six days (for the daily MCII condition) or used MCII only once (for those assigned to the one-off condition). Daily MCII led to higher reductions in bedtime discrepancy scores for participants with high controlled goal motives in both sensitivity analyses. The effect was especially notable in the analysis in which we excluded participants assigned to the daily condition who completed MCII more than once, where there was an hour decrease in bedtime procrastination. Intention-to-treat analyses (as in our primary analysis) and per-protocol analyses (as in our sensitivity analyses) serve different purposes, namely intention to treat analyses examine the effectiveness of assigning a treatment, whereas per-protocol analyses examine the effect of receiving the assigned treatment (Tripepi et al., 2020). In a direct comparison of the effectiveness of completing multiple bouts of MCII versus a one-off bout of MCII, we provide initial evidence that repeated MCII may be more effective for individuals with strong controlled motives. Ntoumanis and Sedikides (2018) argued that MCII can strengthen commitment for goal pursuit for goals that are of low or no inherent interest or enjoyment (e.g. going to bed on time). Daily practices of MCII for a week might be the 'sweet spot' where such changes start to occur. Future research can investigate this hypothesis by assessing MCII and controlled motivation daily. Identifying ways to strengthen goal pursuit for inherently uninteresting tasks (e.g. doing household chores) is of significant practical value.

A key contribution of the current study is the novel way in which we operationalised bedtime procrastination. Unlike past research, which predominantly measured trait-like features of bedtime procrastination (Hill et al., 2022), we assessed bedtime procrastination in a more comprehensive way, as per its definition. First, our approach considered cases where participants expected physical or psychological deprivation the next day. This criterion is key to maximising the fit between the measurement of bedtime procrastination and its concept definition (Kroese et al., 2014), yet this subjective evaluation is absent among assessment protocols of existing research. Second, we discarded bedtime delay cases where participants provided a valid reason for their delay. For instance, if a participant had to postpone their bedtime because they had a 'family emergency' or 'had an unexpected visitor', it is unreasonable to hold them accountable for their delay. Only one study has considered this criterion in assessing bedtime procrastination, yet they excluded a detailed explanation of how valid reasons were assessed and determined (Schmidt et al., 2024). Conversely, we used a preregistered, multi-rater approach to categorising validity reasons and made our categorisations openly available. Moreover, to adequately assess bedtime procrastination in line with its definition, it is essential to measure bedtime procrastination

at the daily level. Bedtime procrastination fluctuates substantially from day-to-day, as demonstrated in this study and others (e.g. Kühnel et al., 2018). Most studies that have examined bedtime procrastination employ cross-sectional designs (Hill et al., 2022), which can only capture average tendencies for bedtime delay and are unable to examine specific reasons for bedtime delay or expectations of being deprived.

Strengths of this study include assessing bedtime procrastination longitudinally in line with the definition for the first time, examining the superiority of daily MCII over single MCII, and considering how motivational factors relate to MCII. A key consideration for future research is whether this finding generalises to other goals that are similarly influenced by daily fluctuations in opportunities for goal pursuit (e.g. physical activity) or barriers to goal attainment (e.g. smoking cessation). For instance, people are subject to various triggers after they quit smoking, which may be activated out of habit or from contextual cues (e.g. alcohol; Kahler et al., 2010). By using MCII daily, people could think ahead of situations where they might experience such triggers throughout the day and proactively prepare coping strategies, which might prove more effective than a single MCII training.

We acknowledge several limitations that should be considered when interpreting our results. First, we computed participants' bedtime discrepancy scores only when they completed back-to-back evening and morning surveys to maximise congruence with our concept definition. Although this decision increased alignment with the operationalisation of bedtime procrastination, it also meant we had to remove 284 (14%) daily surveys from the primary analysis. Future work needs to plan proactively and implement strategies to maximise participants' adherence to survey protocols if they wish to operationalise bedtime procrastination in this way (e.g. automating the data collection; Xu et al., 2018). Second, we relied on participants' best guesses of their actual bedtime and waketime, which may have introduced recall errors or biases. Where resources permit, future research should complement self-reports with device-based assessments that capture sleep metrics unobtrusively and with robustness. Third, only one-third of participants randomised to the single MCII group reported they practised MCII just once. Although this finding likely speaks to the ease of using MCII daily, we are unaware how many times these participants practised MCII over the week. Nevertheless, the results of the sensitivity analysis with those individuals who practised just once were largely comparable to the main analysis. Finally, our evaluations of the reasons that participants provided for their bedtime delay relied solely on the inferences we could make based on the information written down. We coded the reasons with two separate researchers and reached high interrater reliability. Although this process inevitably introduces subjectivity in the decision-making process, subjectivity is inherent in the way bedtime procrastination is defined (e.g. what constitutes a 'valid' reason for bedtime delay?). This process could be further improved by asking participants' own subjective evaluations of whether their reason was valid or not. This additional check could be used to identify cases in which researcher and participant schemas for valid/invalid bedtime delays converge and contrast.

In conclusion, our findings support the interpretation that daily application of MCII appears to be an effective and easy-to-implement strategy that can help reduce bedtime procrastination. Valshtein et al. (2020) showed that a single MCII training is more effective than just giving participants information on sleep health. Here, we

found that the MCII training can be practised daily and results in lower bedtime procrastination than a single implementation. Few studies have directly compared the effect of differing MCII doses. Our results could potentially generalise beyond the context bedtime procrastination and have wide-reaching implications for the implementation of MCII as a technique for goal promotion. In particular, our sensitivity analyses provide initial evidence that repeated MCII may be more effective than one-off MCII in individuals with controlled motives. Within-participant study designs are required to uncover the intricacies between goal motives (especially controlled goal motives) and bedtime procrastination. Moreover, we show how a within-participant approach can provide an improved way of assessing bedtime procrastination that incorporates the necessary and sufficient conditions to characterise a bedtime delay as bedtime procrastination. We demonstrate that this approach is both feasible and informative. We contend that our operationalisation of bedtime procrastination represents the only method presently available that captures bedtime procrastination in a way that is congruent with its definition, and should thus form the gold standard approach for measuring bedtime procrastination.

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