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Boredom affects sleep quality: The serial mediation effect of inattention and bedtime procrastination

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ABSTRACT

Boredom has received much research attention in procrastination research, but it has been rarely studied in the context of bedtime procrastination. In the present study, we examined a serial mediation model and hypothesized that the association between boredom and poor sleep quality could be mediated serially by inattention and bedtime procrastination. Boredom was measured as boredom proneness, fidgeting, and mind wandering. We conducted a correlational study on a sample of 270 participants (women = 198, men = 72) aged between 18 and 69 (M = 22.39, SD = 5.41). The analysis with boredom proneness as the predictor showed that boredom proneness predicted inattention, which in turn was associated with increased bedtime procrastination and subsequently poorer sleep quality. However, the analyses with fidgeting and mind wandering as predictors did not yield significant serial mediation effects. Rather, fidgeting and mind wandering, respectively, were associated with poor sleep quality indirectly via bedtime procrastination only. The findings shed light on how boredom affects bedtime procrastination and brought important implications to the interventions in dealing with bedtime procrastination.

1. Introduction

Bedtime procrastination refers to delay in going to bed deliberately, which lacks valid external reasons of doing so and can foresee negative consequences of such behaviors (Kroese, de Ridder, Evers, & Adriaanse, 2014). Research in bedtime procrastination branches out from procrastination research less than 10 years ago and hence is a relatively young area of study. In bedtime procrastination research, researchers such as Kroese (e.g., Kroese et al., 2014) have studied how bedtime procrastination affects sleep quality, how the lack of self-regulation contributes to bedtime procrastination, and how self-regulation training could help reducing it (e.g., Exelmans & Van den Bulck, 2017a; Kroese, Evers, Aiaanse, & de Ridder, 2016). These studies found that bedtime procrastination remained a significant contributing factor to sleep insufficiency even after controlling for participants' demographics (i.e. age and gender) as well as self-regulation (Kadzikowska-Wrzosek, 2020; Kroese et al., 2014). As sleep insufficiency is a serious health issue as it compromises an array of physiological functioning (Mullington, Haack, Toth, Serrador, & Meier-Ewert, 2009), it is important to examine what contributes to bedtime procrastination.

Boredom, a variable associated with self-regulation failure (Isacescu, Struk, & Danckert, 2017), has been studied intensively in relation to procrastination in general (e.g., Ferrari, 2000; Vodanovich & Rupp, 1999). However, it has yet been studied in relation to bedtime procrastination. In the present study, we aimed to examine how boredom contributes to bedtime procrastination.

1.1. The predictor of bedtime procrastination: boredom

In the early studies on bedtime procrastination, research mainly focused on self-regulatory processes as the contributor to bedtime procrastination (e.g., Kroese et al., 2014). Going to bed later than intended has to do with low self-regulation as bedtime procrastinators are more responsive to distractions (Kroese et al., 2014) and they are depleted of resources for self-regulation after a long day at work (Kamphorst, Nauts, De Ridder, & Anderson, 2018). However, in more recent studies, research associated bedtime procrastination with a myriad of factors despite still being related to the topic of self-regulation, such as bedtime routine aversion, wake-up aversion, and media use before bedtime (Exelmans & Van den Bulck, 2017b; Nauts, Kamphorst, Stut, De Ridder, & Anderson, 2019; Nauts, Kamphorst, Sutu, Poortvliet, & Anderson, 2016). Boredom, a variable related to self-regulation failure, has been

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studied intensively in procrastination research (e.g., Ferrari, 2000). However, it was rarely studied in bedtime procrastination research.

Boredom is a broad term that describes a state of low interest, low arousal, high dissatisfaction, high distractibility, and task disengagement (Carriere, Seli, & Smilek, 2013; Farmer & Sundberg, 1986; Fisherl, 1993; Mikulas & Vodanovich, 1993). Procrastination researchers have generally studied boredom as a personality characteristic (termed boredom proneness), which refers to the tendency to feel bored and the inability to stay mentally stimulated (Malkovsky, Merrifield, Goldberg, & Danckert, 2012). Other boredom-related factors that have been studied include fidgeting and mind wandering, both of which are ways to cope with boredom. People cope with boredom by fidgeting or making spontaneous movements to compensate for the absence of external stimulation (Carriere et al., 2013), which actions are usually not directly related to the task at hand (Mehrabian & Friedman, 1986). People also cope with boredom with mind wandering to allow their mind to drift away from the current task to their own thoughts (Carriere et al., 2013).

While boredom proneness, fidgeting, and mind wandering are similar concepts under the umbrella of boredom, there are dissimilarities among them. Boredom proneness is a personality trait; fidgeting involves behavioral activities; and mind wandering is mind activities (Carriere et al., 2013; Martin, Sadlo, & Stew, 2012; Morris & Warne, 2017). These three variables also differ in terms of the need for stimulation. Boredom proneness tends to be in need for stimulation (Csikszentmihalyi, 1990; Martin et al., 2012); fidgeting is a behavioral activity performed to increase stimulation, sometimes as a way to cope with boredom (Morris & Warne, 2017); and mind wandering is independent of stimulus (Carriere et al., 2013).

Numerous studies have examined the association between boredom proneness and sleep insufficiency. They generally showed that boredom compromised sleep quality (e.g., Tanaka & Shirakawa, 2004; Zhang et al., 2009). Such association could be explained by the urge to get rid of boredom. Despite tiredness, bored people refuse to go to bed and tempt to find something interesting to do (Martin, Sadlo, & Stew, 2006). Such an urge to find stimulation, when occurs near bedtime, might contribute to bedtime procrastination.

Research linking fidgeting to sleep quality has been scarce. However, indirect evidence from children with restless legs syndrome, a disorder generally associated with fidgeting, suggested that fidgeting compromises sleep quality (Picchietti, England, Walters, Willis, & Verrico, 1998). Research using typically developing adults showed a high tendency for fidgeters to seek stimulation through fidgeting (Morris & Warne, 2017). Therefore, the association between fidgeting and sleep quality might have to do with the urge to seek stimulation.

Mind wandering (i.e. losing track of time) was associated with low sleep quality (Nauts et al., 2019). Mind wanderers report a spontaneous drifting of attention to thoughts that are irrelevant to the present experience (Smallwood & Schooler, 2006). Therefore, such drifting of attention might lead mind wanderers to lose track of time and go to bed later than intended, compromising their overall sleep (Nauts et al., 2019).

From the discussion above, boredom proneness, fidgeting, and mind wandering could predict poorer sleep quality. Such associations could be explained by the lack of attention and bedtime procrastination. People who are prone to boredom and those who fidget tend to experience inattention due to the urge to seek stimulation, which in turn lose focus on the passage of time (Farmer & Sundberg, 1986) and might delay bedtime. Mind wanderers, on the other hand, have their focus shifted from the present experience.

1.2. Inattention and bedtime procrastination as the underlying mechanisms

Inattention and bedtime procrastination could be the underlying mechanism that explains the links between boredom-related variables and sleep quality. Several correlational studies (e.g., Kass, Wallace, & Vodanovich, 2003; Malkovsky et al., 2012) have reported boredom predicts inattention. In general, the findings showed that people who tended to experience boredom scored lower on attention (Kass et al., 2003), higher on distractibility (Wallace, Kass, & Stanny, 2002), higher on inability to maintain mindful awareness in activities, and symptoms of Attention Deficit Hyperactivity Disorder (ADHD; Malkovsky et al., 2012).

People who are lack of attention tend to have more sleep-related difficulties. In a study comparing children with ADHD (majority of which were of the inattentive subtype) and those without ADHD, children with ADHD reported higher bedtime resistance, more sleep onset difficulties, and a higher sleep latency as compared to those without ADHD (Vélez-Galarraga, Guillén-Grima, Crespo-Eguílaz, & Sánchez-Carpintero, 2016). In another study using children who visited pediatric clinics, children displaying signs of inattention and hyperactivity reported more acute daytime sleepiness, which is associated with insufficient sleep (Chervin et al., 2002). In a study on typically developing children (Gruber et al., 2012), children whom teachers reported to have more ADHD-like symptoms (cognitive problems and inattention) tended to have shorter sleep duration.

The evidence above, together with the review in the previous subsections on the associations between boredom and bedtime procrastination and between bedtime procrastination and sleep quality, inattention and bedtime procrastination seem to link boredom to sleep quality. Furthermore, borrowing from procrastination research, literature has shown that attention deficits promote procrastination (e.g., Bolden & Fillauer, 2019; Dewitte & Schouwenburg, 2002; Niermann & Scheres, 2014). In other words, inattention and procrastination do not occur simultaneously but sequentially. To explain such association from a neurobiological perspective, procrastination is associated with the over-active limbic system that is responsible for reinforcing behaviors and the decreased prefrontal cortex functioning which controls attention (Bolden & Fillauer, 2019). In a similar vein, behavioral data showed that people who scored high on general procrastination had more inattention symptoms, such as showing problems with sustaining attention and organizing tasks and being easily distracted (Niermann & Scheres, 2014). Therefore, we have reason to believe that inattention and bedtime procrastination could sequentially explain the association between boredom and sleep quality.

1.3. Aims and hypotheses

The present study aimed to examine how boredom (boredom proneness, fidgeting, and mind wandering) contributes to bedtime procrastination. We predicted that boredom would have a negative association with sleep quality and that such association would be mediated serially by inattention and bedtime procrastination. In other words, a higher level of boredom would be associated with poorer attentional level, which would then be associated with higher bedtime procrastination. Higher bedtime procrastination would in turn be associated with poorer sleep quality.

2. Methods

2.1. Participants

Based on G*Power analysis (version 3.1.9.4), for a linear multiple regression analysis with a small to medium effect size ($f^2 = 0.05$) and power of 0.80, a sample size of 222 is recommended. Altogether, we recruited 270 participants (women = 198, men = 72) aged between 18 and 69 ($M = 22.39$, $SD = 5.41$). Of these participants, we recruited 109 from the university's research participant pool, and they received one research credit point to fulfill the research participation requirement in introductory psychology subjects. We recruited the remaining participants through social media and gave no compensation.

2.2. Design

The study was a correlational study. The predictor was boredom, which was measured using three measures, including boredom proneness, fidgeting, and mind wandering. The mediating variables were inattention and bedtime procrastination, and the outcome variable was sleep quality.

2.3. Measures

2.3.1. Boredom Proneness Scale (BPS; Farmer & Sundberg, 1986)

It is a 28-item self-report questionnaire used to measure boredom proneness. Participants rated the items on how they experienced in general on a seven-point Likert scale, ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scale had high Cronbach's alphas in previous studies, indicating good internal consistency (Farmer & Sundberg, 1986; Gerritsen, Toplak, Sciaraffa, & Eastwood, 2014). It also had good test-retest reliability over a one-week interval. Additionally, strong correlations with other boredom measures indicated good validity of the scale (Farmer & Sundberg, 1986). In the present study, BPS displayed high internal consistency ($\alpha = 0.82$).

2.3.2. Fidgeting Scale (FS; Carriere et al., 2013)

This is a seven-item self-report questionnaire used to measure perceived fidgeting behavior on a six-point Likert scale, ranging from 1 (*almost never*) to 6 (*almost always*). Participants rated each item on how they experienced in general. It had high internal consistency in a previous study (Carriere et al., 2013) and a Cronbach's alpha of 0.88 in the present study. Additionally, FS had high convergent and discriminant validity (Carriere et al., 2013).

2.3.3. Mind Wandering Questionnaire (MWQ; Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013)

This is a five-item questionnaire used to assess mind wandering on a six-point Likert scale, 1 (*almost never*) to 6 (*almost always*). Participants rated each item on how they experienced in general. Past studies documented high internal consistency for the original version of the scale (Mrazek et al., 2013) and a translated version (Salavera, Urcola-Pardo, Usán, & Jarie, 2017). The scale had high convergent validity with existing measures of mind-wandering and related constructs (Mrazek et al., 2013). The present study found a high Cronbach's alpha value of 0.81.

2.3.4. Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003)

MAAS measures mindful attention, being aware of the present moment, using 15 items. The instructions of each questionnaire required participants to rate each item based on how they felt the day before. The original Likert scale ranges from 1 (*almost always*) to 6 (*almost never*), with higher scores indicating greater mindful attention. However, for the ease of interpretation of findings, we reversed the scale to 1 (*almost never*) and 6 (*almost always*), with higher scores indicating greater inattention. The MAAS had high Cronbach's alpha values ranging from 0.80 to 0.87 and possessed high test-retest reliability and convergent and discriminant validity (Black, Sussman, Johnson, & Milam, 2012; Brown & Ryan, 2003). In the present study, the scale had a high internal consistency ($\alpha = 0.86$).

2.3.5. Bedtime Procrastination Scale (BePS; Kroese et al., 2016)

BePS assesses bedtime procrastination. Participants rated the 9 items of the scale based on their experience the day before on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*). The scale had good test-retest reliability (Herzog-Krzywoszanska & Krzywoszanski, 2019; Kroese et al., 2016). In the present study, BePS had a high Cronbach's alpha of 0.83.

2.3.6. Groningen Sleep Quality Scale (GSQS; Simor, Köteles, Bódizs, & Bárdos, 2009)

The scale measures sleep quality based on their sleep the night before on a true-false scale. The GSQS had high Cronbach's alpha values in previous studies (Knufinke, Nieuwenhuys, Geurts, Coenen, & Kompier, 2018; Simor et al., 2009). It also had high convergent and discriminant validity (Simor et al., 2009). The scale had a high Cronbach's alpha value of 0.84 in the present study.

2.3.7. Demographic questionnaire

Participants answered two demographics questions related to their age and gender and four additional questions related to the potential reasons for delayed bedtime or poor sleep, which might affect bedtime procrastination and sleep quality. These questions included working night shifts, personal responsibilities (i.e. looking after children, siblings, or parents), presence of existing sleep disorder, and use of medications. Participants answered each question by indicating yes or no.

After reverse scoring some items, we computed the average scores for fidgeting (FS), mind wandering (MWQ), inattention (MAAS), and bedtime procrastination (BePS) and computed the summed scores for boredom proneness (BPS) and sleep quality (GSQS) as suggested by the original validation papers of the questionnaires. Higher scores in each variable indicate a higher level of the associated psychological construct.

2.4. Procedure

Upon obtaining an ethics clearance, we recruited participants via social media, the university's research management system (i.e., the SONA system), posters, and word of mouth. Interested participants clicked the link to the online survey on Qualtrics. The online survey first showed participants the information sheet and informed consent form. Participants who disagreed to participate clicked the "Disagree" button and exited the survey. Those who clicked the "Agree" button to provide an informed consent proceeded to the questionnaires. The online survey presented the questionnaires and the items within each questionnaire in a randomized order, except for the demographic questionnaire which always came last. After the completion of the questionnaires, the online survey displayed a thank you note to thank participants for their participation.

3. Results

We performed all statistical analyses using IBM SPSS Statistics (version 25).

3.1. Assumptions testing

Before conducting the main analyses, we tested the assumptions of multiple regression. All variables satisfied the normality assumption, except for boredom proneness and bedtime procrastination. We found a univariate outlier in boredom proneness. No other univariate and multivariate outlier was found. All variables appeared to be homoscedastic and satisfied the assumption of absence of multicollinearity. We performed subsequent analyses using the dataset with and without the univariate outlier. Because both sets of analyses generated the same findings, we reported the results based on the dataset without the outlier ($N = 269$).

3.2. Preliminary analyses

We conducted Pearson's correlation analyses to see how the study variables were associated with each other. Table 1 shows that all the study variables were significantly correlated with each other.

We conducted independent sample *t*-tests to examine whether sleep quality was affected by the demographic items (see Table 2 for the

Table 1
Correlation coefficients of the associations among boredom proneness, fidgeting, mind wandering, inattention, bedtime procrastination, and sleep quality.

	BP	Fidgeting	MW	Inattention	BeP	SQ
BP	–					
Fidgeting	0.27**	–				
MW	0.41**	0.48**	–			
Inattention	0.52**	0.45**	0.60**	–		
BeP	0.18**	0.28**	0.27**	0.21**	–	
SQ	−0.21**	−0.19**	−0.21**	−0.28**	−0.25**	–

Note. BP = boredom proneness; MW = mind wandering; BeP = bedtime procrastination; SQ = sleep quality.
** Significant at the 0.01 level (2-tailed).

Table 2
The effects of demographic variables on sleep quality.

Demographic variables		Yes	No	*t* value
My job requires me to work night shifts	*n*	39	230	−1.65
	M	7.82	8.85	
	SD	3.55	3.60	
I need to take care of my child/ren, sibling, or parent	*n*	33	236	−1.71
	M	7.70	8.84	
	SD	3.70	3.57	
I have a sleep disorder (e.g., insomnia, hypersomnia)	*n*	51	218	−6.10***
	M	6.10	9.31	
	SD	3.83	3.27	
I am on medication/s that affect my sleep	*n*	22	247	−5.34***
	M	4.95	9.03	
	SD	3.05	3.46	

Demographic variable		Women	Men	*t* value
Gender	*n*	198	71	−2.14*
	M	8.42	9.48	
	SD	3.63	3.43	

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

items). The variables that significantly affected sleep quality would be controlled as covariates in the main analyses. The results showed that women, participants with sleep disorders, and participants who took medications tended to have poorer sleep (see Table 2). Therefore, these three variables were controlled in subsequent analyses as covariates. A correlation analysis between sleep quality and age showed a nonsignificant correlation, $r(267) = 0.02$, $p = .717$. Therefore, we did not control age as a covariate.

3.3. Hypothesis testing

We performed hypothesis testing using SPSS macro PROCESS version 3.4.1 (Hayes, 2013) model 6, (i.e., serial mediation analysis). In these analyses, we entered boredom as the independent variable, sleep quality as the dependent variable, and inattention and bedtime procrastination as the mediators. Since we assessed boredom in three components, boredom proneness, fidgeting, and mind wandering, three sets of mediation analyses were run with boredom proneness, fidgeting, and mind wandering as the independent variable respectively.

3.3.1. Boredom proneness

When boredom proneness was entered as the predictor, it significantly predicted poorer sleep quality, $b = -0.03$, $t = -2.92$, $p = .004$, and accounted for 19.6% of the variance in the model. Fig. 1 shows the regression coefficients of the mediation model. After controlling for the covariates, boredom proneness predicted a higher level of inattention, but it did not predict bedtime procrastination. Higher inattention was associated with a higher level of bedtime procrastination, but it did not significantly predict sleep quality. Bedtime procrastination predicted poorer quality of sleep.

When both inattention and bedtime procrastination were considered as mediators, they significantly, sequentially mediated the relationship between boredom proneness and sleep quality, indirect effect = −0.003, *CI* [−0.006, −0.000], supporting the hypothesis. The indirect effect through inattention as the sole mediator on the relationship between boredom proneness and sleep quality showed that inattention could not sufficiently explain the relationship, indirect effect = −0.012, *CI* [−0.027, 0.001]. Bedtime procrastination as the sole mediator could not sufficiently explain the relationship between boredom proneness and sleep quality, indirect effect = −0.004, *CI* [−0.009, 0.001]. The direct effect was not statistically significant, $b = -0.01$, $t = -1.11$, $p = .270$, indicating a complete mediation.

3.3.2. Fidgeting

When fidgeting was entered as the predictor (see Fig. 2), it did not significantly predict sleep quality, $b = -0.35$, $t = -1.75$, $p = .081$, and it accounted for 18.0% of the variance in the model. After controlling for

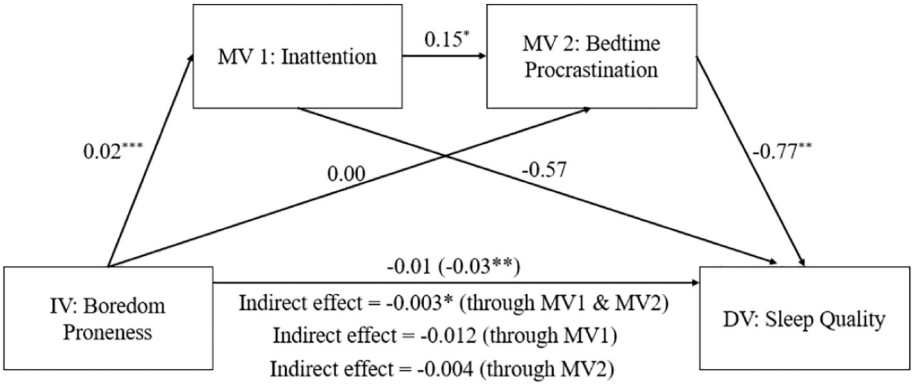

Fig. 1. The serial mediation effect of inattention and bedtime procrastination in the relationship between boredom proneness and sleep quality. Note: The values above the indirect effects are the direct effect and total effect (in parenthesis). The values in the figure are unstandardized regression coefficients. All values are rounded up to 2 decimal places. *** $p < .001$, ** $p < .01$, * $p < .05$.

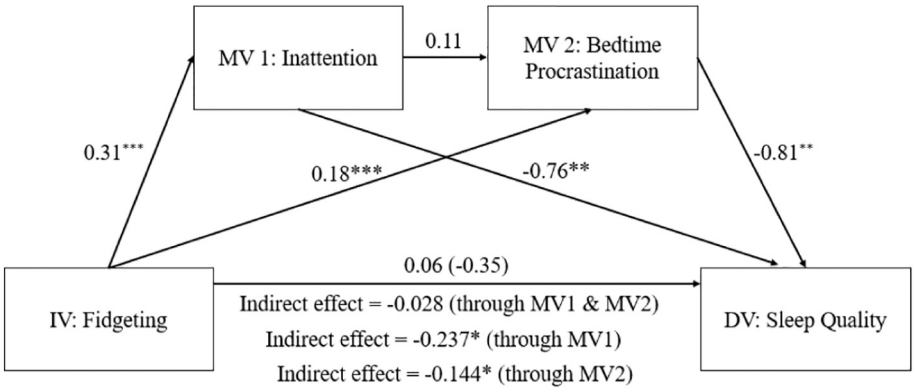

Fig. 2. The serial mediation effect of inattention and bedtime procrastination in the relationship between fidgeting and sleep quality. Note: The values above the indirect effects are the direct effect and total effect (in parenthesis). The values in the figure are unstandardized regression coefficients. All values are rounded up to 2 decimal places. *** $p < .001$, ** $p < .01$, * $p < .05$.

the covariates, fidgeting predicted a higher level of inattention and a higher level of bedtime procrastination. Higher inattention did not predict bedtime procrastination, and it significantly predicted poorer sleep quality. Bedtime procrastination predicted poorer quality of sleep.

Inattention and bedtime procrastination did not serially mediate the relationship between fidgeting and sleep quality, indirect effect = −0.028, *CI* [−0.077, 0.006]. This finding was not in line with the hypothesis. Inattention could explain the relationship between fidgeting and sleep quality, indirect effect = −0.237, *CI* [−0.447, −0.043]. Bedtime procrastination could also explain the relationship, indirect effect = −0.144, *CI* [−0.280, −0.040]. The direct effect was not statistically significant, $b = 0.06$, $t = 0.29$, $p = .776$, which showed a complete mediation.

3.3.3. Mind wandering

Mind wandering significantly predicted poorer sleep quality, $b = -0.51$, $t = -2.48$, $p = .014$, and accounted for 18.9% of the variance in the model (Fig. 3). After controlling for the covariates, mind wandering predicted a higher level of inattention and bedtime procrastination. Higher inattention was not associated with bedtime procrastination, but it did significantly predict sleep quality. Bedtime procrastination predicted poorer quality of sleep.

The serial mediation effect of inattention and bedtime procrastination in the relationship between mind wandering and sleep quality was not significant, indirect effect = −0.026, *CI* [−0.092, 0.025]. This finding was not in line with the hypothesis. Inattention significantly mediated the relationship between mind wandering and sleep quality, indirect effect = −0.337, *CI* [−0.670, −0.022]. On the other hand, bedtime procrastination significantly mediated the relationship between mind wandering and sleep quality, indirect effect = −0.148, *CI* [−0.304, −0.032]. The direct effect was not statistically significant, $b = -0.00$, $t = -0.01$, $p = .994$, indicating a complete mediation.

4. Discussion

4.1. Summary of findings

In the present study, we aimed to examine how inattention and bedtime procrastination contribute to explaining the association between boredom and sleep quality. Our findings provided partial support to the hypotheses. Specifically, the results supported the hypothesis related to boredom proneness but did not support the hypotheses related to fidgeting and mind wandering. Boredom proneness predicted inattention, which in turn was associated with increased bedtime procrastination and subsequently poorer sleep quality. However, for the associations between fidgeting and sleep quality and between mind wandering and sleep quality, inattention and bedtime procrastination did not mediate the associations serially. Rather, such associations were mediated by bedtime procrastination alone. In other words, inattention did not account significantly for the associations.

4.2. Theoretical implications

Boredom has been studied widely in procrastination research. However, in the context of bedtime procrastination, it has always been overlooked. In the present study, we examined boredom-related

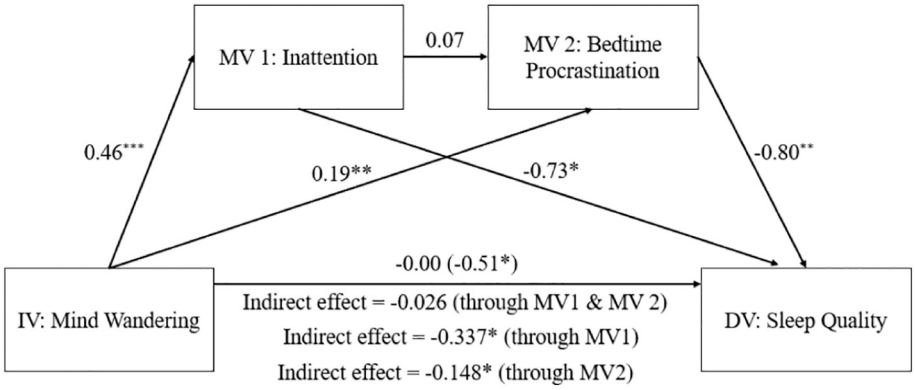

Fig. 3. The serial mediation effect of inattention and bedtime procrastination in the relationship between mind wandering and sleep quality. Note: The values above the indirect effects are the direct effect and total effect (in parenthesis). The values in the figure are unstandardized regression coefficients. All values are rounded up to 2 decimal places. *** $p < .001$, ** $p < .01$, * $p < .05$.

predictors and the underlying mechanism of bedtime procrastination and poorer sleep quality. The findings bring important theoretical implications to bedtime procrastination research.

4.2.1. Boredom as a predictor of bedtime procrastination

In previous studies on bedtime procrastination, self-regulation has remained the focus of research attention. These studies documented that bedtime procrastinators are generally those with a lower ability to self-regulate (Kroese et al., 2014), those who have limited resource to self-regulate (Kamphorst et al., 2018), and those who fail to regulate pre-bedtime behaviors (e.g., Nauts et al., 2016).

The present study added to the existing literature and documented boredom to be an important predictor of bedtime procrastination. Those who are prone to boredom, those who fidget frequently, and mind wanderers are more likely to procrastinate their bedtime. Boredom is considered a consequence of self-regulation failure (Isacescu et al., 2017; Struk, Scholer, & Danckert, 2016). It is also associated with dys-regulation in cognition and affection, such as attention level, depression, and hostility (Isacescu et al., 2017). Our findings aligned with previous studies such that self-dysregulation contributes to bedtime procrastination.

4.2.2. The mechanism

In the present study, we investigated how inattention and bedtime procrastination explain the compromised sleep quality among people who are prone to boredom, fidgeters, and mind wanderers. The serial mediation involving boredom proneness as the predictor was established, whereas those involving fidgeting and mind wandering as the predictors were not established. Such findings could be due to the inherent differences among these boredom-related variables. Boredom proneness refers to a personality trait, a *tendency* to experience boredom, and the frequency of such experience (Elpidorou, 2014). Fidgeting and mind wandering, on the other hand, are *specific* responses to the feeling of boredom (Morris & Warne, 2017). Mind wandering refers to mind activities (Carriere et al., 2013), which makes it different from fidgeting that involves behavioral activities (Morris & Warne, 2017).

In the present study, inattention explains how boredom proneness is linked to bedtime procrastination and sleep quality. This is probably because the tendency of experiencing boredom drives people to escape from a boresome state. Such drive informs individuals to focus on alternative goals and interests (Elpidorou, 2014) and hence not being mindfully attentive to the present moment. Boredom proneness is a general tendency that might drive focus to all alternatives available, be it behavioral or mental alternatives. A measure of general lack of mindful attention, such as the MAAS (Brown & Ryan, 2003) used in the present study, is sufficient in capturing the responses.

In the present study, the serial mediation analyses with fidgeting and mind wandering as the predictors showed that the two predictors did not predict sleep quality through inattention and bedtime procrastination serially. Nonetheless, these two predictors predicted poorer sleep quality through bedtime procrastination alone, indicating the importance of fidgeting and mind wandering in bedtime procrastination. The behavior of getting on a sleep schedule is not only susceptible to behavioral distraction but also thought distraction.

Individuals who fidget frequently cope with the present (boring) moment by placing focus on other behavioral alternatives, such as using social media. People who feel bored tend to report a more intense use of social media (Whelan, Najmul Islam, & Brooks, 2020). In the blink of an eye, hours could have passed, and the person could have inadvertently delayed their bedtime. Of the behavioral alternatives available, people generally prefer activities that require less attention when they had already had insufficient sleep the night before (Mark, Wang, Niiya, & Reich, 2016). While behavioral alternatives make bedtime procrastinators lose track of time by occupying them with activities (Farmer & Sundberg, 1986), mind wandering does so by keeping bedtime procrastinators' mind drifting from the present experience (Smallwood & Schooler, 2006).

Our findings showed that being mindfully attentive to the present moment is not a suitable mechanism accountable for how fidgeters and mind wanderers procrastinate their bedtime. Differed from boredom proneness, fidgeting and mind wandering are approaches to cope with boredom (Morris & Warne, 2017). They involve specific activities conducted to deal with boredom. Therefore, mindful attention might be too broad a term which could not capture the specific mechanisms involved. This calls for more research effort to search for a more suitable mechanism.

One suitable mechanism to explain bedtime procrastination among mind wanderers is meta-awareness, or the ability to be aware of the content of current thought (Schooler et al., 2011). Having high meta-awareness is important in the context of mind wandering because it helps us monitoring our current thought. We may pull our attention to the present moment once we notice our mind drifts away. However, mind wanderers often have low meta-awareness, failing to keep track of their current thought (Schooler, 2002). Therefore, low meta-awareness could account for the bedtime procrastination among mind wanderers. While meta-awareness is more relevant to mind wandering, it is not suitable to explain bedtime procrastination among fidgeters which involves behavioral activities. For fidgeting, a more suitable mechanism could be action-awareness, or being aware of the current actions.

In sum, rather than a broad term of mindful attention, specific aspects of mindful attention might be more suitable in explaining bedtime procrastination among fidgeters and mind wanderers. Specifically, being aware of the current thought might be suitable for mind wanderers, whereas being aware of the current action might be suitable for fidgeters. These are hypotheses that need further research investigation.

4.3. Practical implications

Our findings suggested two approaches to decrease bedtime procrastination. These include decreasing boredom proneness and dealing with inattention.

4.3.1. Decreasing boredom

Since boredom proneness, fidgeting, and mind wandering predicted bedtime procrastination, decreasing the levels of these boredom-related variables might be able to deal with bedtime procrastination. Based on previous literature, there are several ways to decrease boredom proneness. One of these is through self-regulation skills.

We may improve self-regulation skills because they predict boredom proneness (Struk et al., 2016). Valshtein, Oettingen, and Gollwitzer (2020) examined a self-regulation intervention to deal with bedtime procrastination, termed mental contrasting with implementation intentions (MCII). MCII includes two components – mental contrasting and implementation intentions. Mental contrasting requires participants to identify a wish and imagine the best outcome of the wish. They then identify the obstacles that may hinder the best outcome and identify instrumental behaviors that may overcome the obstacles. Subsequently, participants move on to the next stage of intention implementation when they specify when, where, and how an intention should be implemented. In the context of bedtime procrastination, an example could be "If it is 11pm, my planned bedtime, then I will stop all activities and start my bedtime routine (e.g., brushing teeth)." Valshtein and colleagues found that MCII, relative to the control condition, not only increased participants' commitment to overcome bedtime procrastination but also reduced the actual behaviors of bedtime procrastination. Although it is not clear whether such self-regulation intervention reduces boredom, we have reasons to believe that it might because it provides a clear behavioral alternative that may keep procrastinators occupied both behaviorally and mentally.

4.3.2. Dealing with inattention

The second approach to decrease bedtime procrastination is to train

mindful attention. Our findings showed that the mechanism accountable for bedtime procrastination among people prone to boredom was inattention, or not being mindfully attentive to the present moment. People prone to boredom may get fidgety or mind-wander to seek stimulation (Csikszentmihalyi, 1990; Morris & Warne, 2017). Training on paying mindful attention to the present moment may help people who are prone to boredom stay focused on time and their current activity. Together with MCII and good planning, mindful attention may direct procrastinators' attention to bedtime-related plans, narrowing their scope of focus from a myriad of behavioral alternatives such as virtual environment to bedtime-related plans.

4.4. Limitations and directions for future research

The present study brought important theoretical and practical implications to bedtime procrastination research. However, it also raised some issues that need further research investigation. First, inattention was insufficient in explaining bedtime procrastination among fidgeters and mind wanderers in the present study. We need more research effort to explore other mechanisms. As discussed earlier, meta-awareness might be appropriate for mind wanderers and action-awareness for fidgeters. Such information is useful in shedding light on interventions customized for each individual to decrease bedtime procrastination based on their personality characteristics and coping approach.

Second, we discussed MCII and mindful attention training as the potential interventions effective in decreasing bedtime procrastination. However, such hypothesis needs to be substantiated with empirical evidence.

Lastly, previous studies have focused mainly on personal factors that contribute to bedtime procrastination. However, environmental factors have been overlooked. Some studies, such as Exelmans and Van den Bulck (2017b) examined electronic media use, but they mainly limited to behaviors instead of environment. Physical, social, and virtual environment may provide important implications to bedtime procrastination. For instance, the number of alternative activities and the level of stimulation in the environment may distract people who are prone to boredom, fidgeters, and mind wanderers. Such topics deserve more research effort.

In conclusion, the present paper contributed to the existing literature by highlighting boredom proneness, fidgeting, and mind wandering as important predictors of bedtime procrastination and sleep quality. We also examined inattention as the underlying mechanism. The findings, although brought important implications, flagged some issues that need further research investigation.

CRediT authorship contribution statement

Ai Ni Teoh: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. **Evangel Yi En Ooi:** Investigation, Project administration, Visualization, Writing - original draft, Writing - review & editing. **Alyssa Yenyi Chan:** Data curation, Formal analysis, Visualization, Writing - original draft, Writing - review & editing.

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