Why Would You Sleep?

A Study on Awareness of Short-term and Long-term Health Consequences of Insufficient Sleep in association with Bedtime Procrastination, moderated by Chronotype

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Abstract

Insufficient sleep is a prevalent problem in society, with various negative health outcomes, short-term as well as long-term. In the current study, bedtime procrastination was investigated, which is defined as failing to go to bed in time, while no external circumstances prevent a person from doing so. The aim of this study was to find out if an association exists between awareness of the health consequences of a lack of sleep and bedtime procrastination, with the hypothesis that more awareness would mean less bedtime procrastination. Secondly, a distinction was made between awareness of short-term and long-term consequences, with the expectation that short-term awareness would have a stronger association with bedtime procrastination. Thirdly, a possible moderating effect of chronotype was investigated, with the expectation that the associations would be stronger among people who tend towards eveningness. A cross-sectional study was done, in which 188 healthy participants aged 19 up to 74 filled in an online questionnaire, of whom 141 were concluded in analyses. A hierarchical regression showed that short-term awareness, but not long-term awareness or awareness as a total of these two, was associated with bedtime procrastination. No moderating effect of chronotype was found. Explanations for these findings are given, as well as strengths and limitations of this study. The findings of this study are of great theoretical and practical value, because they show that prevention programs should focus on short-term and not on long-term health consequences when targeting awareness in the population. Suggestions for future research were given.

Why Would You Sleep?

When talking about mental and physical health, a lot of topics are discussed regularly: nutrition, exercise, alcohol, smoking. Sleep behaviour, however, is not one of them. Recently, three Dutch health institutions did an exploration on the prevention of sleep problems in the Netherlands and concluded that, even though there is a lot of research on treating sleeping disorders like insomnia, knowledge of preventing sleeping problems in the healthy population is less available, which limits the toolbox of health professionals to intervene in this area (Leone, Van der Poel, Beers, Rigter, Zantinge, & Savelkoul, 2018). This lack of awareness concerning risks of insufficient sleep was also suggested by Sorscher (2008), who reported that most health screenings do not include questions about sleeping behaviour, in contrast to questions on eating behaviour and physical activity. Whether people themselves are aware of the consequences of a lack of sleep and if this awareness relates to their behaviours resulting in insufficient sleep, will be investigated in the current study.

More awareness is much needed, because 10% of the Dutch population is not sleeping the recommended number of hours, while not meeting the criteria for a sleeping disorder. Besides that, even among the people who do sleep enough hours, there are a lot of people whose sleep quality is unsatisfactory, for example: 25.4 % of women between 18 and 25 years old reported to have problems with falling asleep (Leone et al., 2018). In the United States, the numbers are even more worrying: 35.2% of all adults sleep less than seven hours per night, which means they sleep less than the recommended amount of hours (Centers for Disease Control and Prevention, 2014).

Getting not enough sleep can cause a lot of mental and physical health problems. To investigate the essence of sleep, a study was conducted in which the participants did not sleep for several nights (Orzeł-Gryglewska, 2010). Discovered consequences were for example disturbances in attention and memory, higher levels of stress and a longer reaction time, which is not only of negative consequence for oneself, but is also extremely dangerous when people have to participate in traffic for example. In another study, it was shown that insufficient sleep in adolescents caused higher risk of depression and obesity (Owens, 2014). In a large scaled meta-analysis on the health outcomes of short sleep, it was found that insufficient sleep causes, among other things, higher mortality rates (Itani, Jike, Watanabe, & Kaneita, 2017). These health risks should and could be prevented, but more insight into sleeping behaviours is needed.

One of these sleeping behaviours that is of essence in the problem of insufficient sleep, is bedtime procrastination. Bedtime procrastination is a problem a lot of people are

familiar with. Imagine the following situation; Tomorrow, you have to get up at 07:00 am, so in order to get enough sleep, you decide you will go to bed at 23:00 pm tonight. In the evening, you are watching your favorite Netflix series and when the episode ends at 22:45 pm, it automatically proceeds to the next episode. Before you know it, it is hours later than the time you intended to go to bed. The next day, you cannot concentrate and decide that tonight, you will really go to bed at 23.00 pm.

If you recognize this situation, you are not the only one. In a quantitative study on this topic, 50% of 2431 participants regularly procrastinated on their bedtimes and 45% of the participants felt tired on at least 2 days of the week (Kroese, Evers, Adriaanse, & de Ridder, 2014). *Procrastination* is defined as a "voluntary delay of an intended course of action despite expecting to be worse off for the delay" (Steel, 2007, p.66). Kroese and colleagues defined *bedtime procrastination* as "failing to go to bed at the intended time, while no external circumstances prevent a person from doing so" (2014). The consequences of this choice can already be experienced the next day, because a lot of people have to be in time for work or school, regardless of the time they went to bed the night before. However, for people who procrastinate on their bedtimes on a more regular basis, the consequences are likely to go even further than being a bit tired the next day.

Regardless the severe consequences bedtime procrastination could cause, a lot of people still shows this behaviour (Kroese et al., 2014). An explanation for this unhealthy behaviour in which people do not live up to their intention of going to bed on a certain time, can be found in the Theory of Planned Behavior (Ajzen, 1991). This theory states that determinants like someone's attitude towards a certain health behaviour result in the intention of showing this behaviour and that this intention results in actually performing this behaviour. However, this intention is not always translated into the actual behaviour. In a recent meta-analysis, Sheeran and Webb described the existence of an intention-behaviour gap; intentions only result in the wanted behaviour in half of the cases (2016). This means that even for the people who are aware of the negative health consequences of a lack of sleep and who therefore may intend to go to bed on time, it could be hard to actually translate this intention into the behaviour of going to bed at that time in the evening.

This intention-behavior gap occurs not only in bedtime procrastination, but also in other health behaviours, which underlying mechanisms are explained by Kroese and De Ridder (2015). The first explanation they propose, is a lack of *self-regulation skills*, which can be defined as someone's ability to alter their own thoughts, emotions, impulses and actions (Baumeister, Heatherton, & Tice, 1994). People who lack these skills, are more easily

tempted by cues in the environment, for example that one extra episode on Netflix, and less focused on their long-term goals, in this case: feeling awake the next day and staying healthy. In this self-regulatory dilemma, the benefits of staying up a bit later are weighed up against the possible consequences, in which the self-regulation skills someone possesses, partly determine which option it will be (Kroese, Evers, Adriaanse, & de Ridder, 2014).

Besides a lack of self-regulation skills, Kroese and De Ridder propose a second explanation for the inconsistency between the intention someone has of going to bed on time and the behaviour in which the opposite is realized (2015). According to the authors, intentions can also temporarily be put aside. Someone can have the intention of going to bed on time in the morning, but just choose not to think about that intention in the evening. The temptations in the self-regulatory dilemma they are facing, could just be too tempting so they rather give in to them than act on their healthier goals. In other words, people could lack the ability of translating their intentions into behaviour, or they could just not want to act on them.

In the described self-regulatory dilemma, it is interesting to see which consequences people include in their decision-making process. In a qualitative study on bedtime procrastination, the following was said concerning the people who indicated making a deliberate choice of going to bed later than they intended to: *"... participants indicated being fully aware of the negative consequences of going to bed late, such as feeling "tired," "lacking in energy," "forgetful," "guilty," "irritable," "passive," and "unable to concentrate.""* (Nauts, Kamphorst, Stut, De Ridder, & Anderson, 2019, p. 756). These are all short-term consequences of a lack of sleep, while the consequences it can have for one's health in the long run were not mentioned by the participants.

This finding is in line with a review stating that long-term consequences, like higher morbidity and mortality rates, are far less-known than the short-term consequences of insufficient sleep (Mullington, Haack, Toth, Serrador, & Meier-Ewert, 2009). Besides that, long-term health consequences of a lack of sleep can be seen as a cumulative risk, which means that practicing this behaviour is only bad for one's health if it occurs multiple times. In a study on smoking, people underestimated the long-term health risks of smoking that "one more cigarette" or even of smoking for a few years (Slovic, 2000). The same could be true for sleeping behaviours. People could think that one short night will not affect their health badly on the long run.

In sum, it is known that even though insufficient sleep does have negative consequences for people's mental and physical health (Orzel-Gryglewska, 2010; Owens,

2014), a lot of people do not sleep enough (Leone et al., 2018). Part of these sleeping problems can be explained by the finding that a substantial part of the population procrastinates on their bedtimes (Kroese, Evers, & Adriaanse, & de Ridder, 2014). In the past few years, a good start was made by researching the mechanisms behind this sleeping behaviour. It was already established that the behaviour in which people intend to go to bed in time, but fail to do so, can be seen as a self-regulatory problem, or as a mechanism in which people temporarily put their intentions aside (Kroese & De Ridder, 2015). This behaviour, however, was never convincingly linked to how aware people are of the possible negative health consequences a lack of sleep can cause. The qualitative study of Nauts and colleagues (2019) did include some questions on awareness, but quantitative research on this topic is lacking. That is why in the current study, the main research question will be to find out if there is a correlation between the extent to which people are aware of the health consequences of sleep deprivation and the extent to which they procrastinate on their bedtimes.

As a first hypothesis, we expect to find a negative association between awareness and bedtime procrastination, meaning that the more aware someone is of the negative health consequences of insufficient sleep, the less they will procrastinate on their bedtimes. According to the study of Nauts and colleagues (2018), the procrastinators were aware of the health consequences of procrastinating on their bedtimes, but still chose to do so. That could mean that there would not be a correlation between awareness and bedtime procrastination. However, we still expect to find one, because both mechanisms described by Kroese and De Ridder (2015) could be influenced by awareness. On the one hand, being aware of the negative health consequences of insufficient sleep could make the option of going to bed late less attractive in the self-regulatory dilemma people face during the evening, which could ease the pressure on someone's self-regulatory skills. On the other hand, being more aware could stimulate someone to actually think of their intentions in the evening. Both could result in less bedtime procrastination.

Secondly, we are interested to see if there is a difference between long-term and short-term health consequences in the extent to which these two types of awareness are associated with bedtime procrastination. We expect this effect to be stronger for awareness of short-term consequences than for awareness of long-term consequences. It could be a logical assumption that long-term consequences are stronger associated with bedtime procrastination because these consequences are far more severe. However, due to the cumulative character of the

long-term health consequences (Slovic, 2000), it is expected that these risks are perceived as less threatening and likely to happen and therefore have less effect on people's behaviour.

Apart from the possibility that people differ in the way they perceive and weigh possible health consequences of insufficient sleep, they can also differ in the biological urge they experience to go to bed or stay awake. When someone is really tired in the evening, less consideration of negative health consequences is needed to make the decision to go to sleep. Whether someone is tired at evening or not, depends partly on their chronotype. According to Fabbri and colleagues, people can be classified on a continuum with two extremes; *morningness* and *eveningness* (Fabbri, Antonietti, Giorgetti, Tonetti, & Natale, 2007). People who tend to morningness are more active in the beginning of the day and prefer to go to bed early at night. People who tend more towards eveningness, on the contrary, are more active in the second part of the day and prefer to go to bed later.

There are already indications of an association between chronotype bedtime procrastination. According to Taillard, Philip and Bioulac (2002), eveningness is associated with less time in bed during the week compared to ideal sleep needs and more irregular sleep- and wake habits, which could be indicators of bedtime procrastination. In line with this is a study among college students, in which a correlation was found between their scores on a morningness-eveningness scale and procrastination in general, suggesting that students who tended more towards eveningness, were more likely to procrastinate on tasks (Digdon & Howell, 2008). More specifically on bedtime, Kühnel, Syrek and Dreher found that people with late chronotypes, so with a tendency towards eveningness, reported more bedtime procrastination than people with early chronotypes (2018).

In the current study, we are interested to see if chronotype, besides possibly influencing bedtime procrastination directly, could also have a moderating effect on the possible associations between short-term and long-term awareness of health consequences of insufficient sleep and bedtime procrastination. This will therefore serve as our third research question. We expect these associations to be more strongly present among people who tend towards eveningness. Keeping in mind that these people are more active and less tired in the evening than people who tend towards morningness (Fabbri et al., 2007), the urge to stay up late is probably higher. This means that the self-regulatory dilemma described by Kroese and colleagues (2014), is expected to be more present in these people. Being aware of the negative health consequences of sleep deprivation, is therefore likely to have a stronger impact on the extent to which they procrastinate on their bedtimes than it would have for the

early birds, who already feel tired so are going to bed on time regardless of how aware they are of the health consequences.

The aim of the current study is to find out if the extent to which being aware of possible negative health consequences of insufficient sleep is associated with bedtime procrastination. Finding out if it is, would tell us if prevention programs aimed at increasing awareness might be helpful. Besides that, making a distinction between awareness of short-term and long-term consequences, could help health professionals to determine on what consequences the focus should be in prevention programs to make sure these are as effective as possible. Furthermore, looking at chronotype could help with defining the target group of these prevention campaigns. More effective and targeted prevention could eventually cause people to procrastinate on their bedtimes less, which would mean better sleep among the population and eventually will benefit public health. These research questions were investigated in a cross-sectional study of a representative sample of the healthy population. The data was collected in a period of two weeks, in which participants filled in an online questionnaire, which measured demographic information, bedtime procrastination, knowledge concerning short-term and long-term consequences of insufficient sleep and chronotype.

Methods

Participants

An a-priori power-analysis was performed with the program G*power 3.1 to determine the intended sample size, assuming an effect-size of 0.15 (medium). To achieve an alpha of 0.05 and a power of 0.8, the minimum sample size should be 160 people. In this study, all adults could participate, except for participants diagnosed with a sleeping disorder and participants who are working night shifts, because this study is supposed to measure behaviours among the healthy population and these factors are likely to influence their sleeping behaviour. Therefore, two questions were added to the questionnaire to identify people who were either diagnosed with a sleeping disorder or who were working night shifts (Appendix). They were excluded from the results. A total of 188 participants filled out the questionnaire, of whom 14 were excluded because of one of these two exclusion criteria. Of the remaining sample, 33 more people had to be excluded, because of missing values. To test if it was safe to delete these cases listwise, Little's MCAR test was completed, which was not significant (p = .13), which means the data is indeed missing at random, so it was statistically

justified to delete these missing values listwise. Of this final sample, (N = 141), 69% was female and a majority of 86.6% was highly educated (obtained a bachelor's degree or higher). The average age was 42.3 years (SD = 15.6), with a minimum of 19 and a maximum of 74.

Design

In order to find out if the quantitative independent variables short-term awareness and long-term awareness correlate with the quantitative dependent variable bedtime procrastination and if this relationship is moderated by chronotype, a cross-sectional study was done, in which participants were asked to fill in an online questionnaire.

Procedure

The data was collected online, via Qualtrics, an online survey system. After entering all questions of the questionnaire in Qualtrics, the questionnaire was completed by two test-participants to make sure everything was well explained and easy to understand. In response to their feedback, one adjustment was made, because they had some difficulties understanding the last part of the questionnaire, in which their chronotype was measured. In the original questionnaire, the 12 hour-notation was used, because this is the most commonly used way of describing the time. However, in the final questionnaire, which was used by collecting the data, 24-hour-notations were added, to make sure no participants were lost because they got confused at this point. All participants were recruited by sharing the questionnaire on social media like LinkedIn and Facebook.

Participation was completely voluntarily, and no rewards were given. Before starting the questionnaire, informed consent was obtained by giving the participants the information on this study and asking them to only continue when they agreed. The fact that they could stop with this study at any point was stressed and an e-mail address was given to make sure all possible questions could be asked. All personal data was anonymized after the data collection was completed. Finally, to make sure this study complies with the General Data Protection Regulation (GDPR), a form from the Faculty Ethics Review Committee (FERC) was completed.

Materials

To collect the needed data, a questionnaire was created, which is included in the appendix. This questionnaire took approximately 10 minutes to complete.

Demographic information. The participants were asked about their age, the sex they identified most with and their highest level of education. This information was gathered, because these variables could confound the possible associations, because they all have

influence on sleep duration (Leone et al, 2018). For gender, there was only one person who did not choose for “male” or “female”, but chose “prefer not to say”, this participant was treated as missing data, which made gender dichotomous. The variable Education was dichotomized, in which no education, elementary school, secondary school and vocational school were recoded into “low educated” and bachelor’s degree, master’s degree and doctoral were recoded into “high educated”.

Bedtime procrastination. The Bedtime Procrastination Scale (Kroese, De Ridder, Evers, & Adriaanse, 2014) was included, to measure to what extent the participants were procrastinating on their bedtimes in the two weeks prior to their participation in this study. Answers were given on a scale from 1 (almost) never to 5 (almost) always, in which a higher score meant more bedtime procrastinating. The internal consistency for this scale was excellent (Cronbach’s $\alpha = .90$). Item 2, 3, 7 and 9 were reverse scored, so they had to be recoded before analysis. The total score of bedtime procrastination consisted of the sum of all 9 items of this scale. In order to report easier to interpret descriptive statistics, a mean score of bedtime procrastination was computed.

Awareness. The “knowledge section” of the Sleep Practices and Attitudes Questionnaire was used, to measure the awareness of the participants concerning health consequences of sleep deprivation (SPAQ; Grandner, Jackson, Gooneratne, & Patel, 2013). Statements were given on possible health consequences of getting not enough sleep and the participants decided on a scale from 1 strongly disagree to 5 strongly agree whether they agreed that these were actually possible consequences of not sleeping enough. A higher score on this part of the questionnaire, meant more awareness.

This part of the questionnaire resulted in three variables: “short-term awareness”, of which the total score was computed by taking the sum of statements 1, 2, 7, 8, 9, 12 and 14 of this section; “long-term awareness”, which was the total-score of statements 3, 4, 5, 6, 10, 11 and 13 of this section; and “awareness total”, which was the sum of all these statements together. In order to report easier to interpret descriptive statistics, we also computed mean scores of these three awareness variables.

The internal consistency for this scale in total was good (Cronbach’s $\alpha = .88$), as well as the internal consistency for short-term awareness (Cronbach’s $\alpha = .85$) as for the internal consistency for long-term awareness (Cronbach’s $\alpha = .82$).

Chronotype. The Horne-Östberg Morningness-Eveningness Questionnaire (MEQ; Horne & Östberg, 1976) was added to find out to which chronotype the participants tend more. Before

analysis, most of the items of this section had to be recoded. The scoring of this part of the questionnaire was a bit more complex, which can be found in the appendix. The total score of chronotype was computed by taking the sum of all 19 items of this last section of the questionnaire. A higher score means that someone tends more toward morningness. The internal consistency for this scale was, again, good (Cronbach's $\alpha = .83$).

In the original MEQ, five subtypes are distinguished, namely "definite evening", "moderate evening", "intermediate", "moderate morning" and "definite morning". However, according to Natale and Cicogna (2002), it makes more sense to use the raw scores of this questionnaire, because otherwise a lot of people fall into the intermediate category. By treating the score as a continuous instead of a categorical variable, more variance can be found in this category. Therefore, in the current study, chronotype was treated as a continuous variable.

Analyses

After recoding the reverse scored items and computing total- and mean scores, the independent variables that would be included into the regression, namely short-term awareness, long-term awareness and chronotype were grand mean centered. To find out if chronotype has a moderating effect, two interaction variables were computed of these centered variables, which resulted in "Short-term awareness*Chronotype" and "Long-term awareness*Chronotype".

Before starting the regression, the assumptions were checked and met. A histogram of the residuals of the dependent variable showed that these were normally distributed. A scatterplot of the standardized residuals versus the predicted values of bedtime procrastination showed a random array of dots, which means that the assumption of linearity and homoscedasticity were met. Also, there was no indication of multicollinearity, because the Variance Inflation Factors of all included variables were within the acceptable range, with a low of 1.02 and a high of 1.93. Lastly, the data was checked for outliers, and three were found. Two of these participants had the highest score possible at "long-term awareness" and one had a very low score at "chronotype". Because their answers in the other sections showed more variability, it was concluded that even though these scores are remarkable, they seem to be correct, so there was no reason to exclude these participants from analyses.

To find an answer to the research questions, a hierarchical multiple regression analysis was conducted. In the first block of the model, the possible confounding variables were added, namely gender, age and education. In the second block, the centered variables of

"short-term awareness" and "long-term awareness" were added. In the third block the centered variable of chronotype was added and in the last block the two interaction variables were added. Based on 141 participants, a power of 0.91 was accomplished, which is a bit lower than aimed for beforehand, but is still high enough to cautiously make conclusions based on the found results.

Results

Descriptives

In Table 1, the descriptive statistics can be found of bedtime procrastination and the awareness variables. Participants scored moderate on bedtime procrastination (M = 2.78, SD = 0.92), which indicates that bedtime procrastination is actually occurring in this sample. As expected, the mean of long-term awareness (M = 2.63, SD = 0.78) is lower than the mean of short-term awareness (M = 3.43, SD = 0.77). A paired sample t-test showed that this difference between the means is significant (t =14.59, p < .001), indicating that the participants are more aware of the consequences of not enough sleep they will experience the next day, than of the long-term consequences sleep deprivation will have on their health. Of the items measuring awareness, the highest mean was found on the statement "If I don't get enough sleep, it can cause me to have less energy the next day" (M = 4.02, SD = 1.05).

Table 1

Descriptives of Bedtime Procrastination and the Awareness Variables

Variable	Minimum	Maximum	Mean
Bedtime procrastination	1.00	4.67	2.78
Short-term awareness	1.29	5.00	3.43
Long-term awareness	1.14	5.00	2.63
Awareness total	1.43	5.00	3.03

Associations between the included variables

In Table 2, the zero-order correlations between bedtime procrastination, short-term awareness, long-term awareness, the total scores of awareness, chronotype and demographics can be found. Bedtime procrastination was negatively associated with age and education, so

these demographics can possibly act as confounding variables when testing for any main effects between awareness and bedtime procrastination, which is accounted for by including them in the main analysis. However, no associations were found between bedtime procrastination and the awareness variables, which is notably because this is not in line with the expectations. Chronotype and bedtime procrastination on the other hand, do show a significant negative correlation (r = -.55, p < .001), which means that the more someone tends to morningness, the less they seem to procrastinate on their bedtimes.

Table 2

Pearson Correlations

	1	2	3	4	5	6	7
1. Bedtime Procrastination							
2. Short term awareness	- .06						
3. Long term awareness	.06	.52*					
4. Awareness total	.00	.88*	.87*				
5. Chronotype	- .55*	- .06	- .04	- .06			
6. Age	- .29*	- .23*	- .02	- .14	.47*		
7. Gender	- .03	.16	.08	.14	.10	- .05	
8. Education	- .20*	.01	.02	.01	.11	.22*	- .07

*Note: * Correlations significant at p < 0.05.*

Predicting bedtime procrastination

In Table 3, the outcomes of the hierarchical regression analysis can be found. Step 1 caused a significant change in the model, which means the confounders are predicting bedtime procrastination for 10.7% ($F_{change}(3, 138) \geq 5.52$, p = .001). Of these confounders, education had the strongest association with bedtime procrastination ($\beta_{standardized}$ = -.17, p = .02). Adding short-term awareness and long-term awareness in Step 2 did not significantly improve the model ($F_{change}(2, 136) \geq 2.9$, p = .05). The reason that the awareness variables did not significantly predict bedtime procrastination in this model, seems to be caused by long-term awareness, which had no significant relation with bedtime procrastination ($\beta_{standardized}$ = .14, p = .10), while short-term awareness did ($\beta_{standardized}$ = -18, p = .04). Adding chronotype in Step 3 caused the strongest change in the model, by predicting the variance in bedtime procrastination with an additional 21.4 % ($F_{change}(1, 135) \geq 45.15$, p < .001). The testing for any interaction effects in Step 4, did not significantly change the model (F_{change} (2, 133) ≥ .20, p = .82).

Table 3

Outcomes of Hierarchical Regression

	standardized ß	*p*	ΔR^2
STEP 1			
			.11
Age	– .07	.44	
Gender	.05	.53	
Education	– .17	< .05	
STEP 2			
			.04
Short-term awareness	– .18	< .05	
Long-term awareness	.14	.10	
STEP 3			
			.21
Chronotype	– . 53	< .001	
STEP 4			
			.00
Chronotype * Short-term awareness	– .02	.85	
Chronotype * Long-term awareness	.06	.56	

Discussion

The aim of this study was to find an answer to three research questions. First, we wanted to establish whether an association exists between the extent to which someone is aware of the possible health consequences of insufficient sleep and the extent to which they procrastinate on their bedtimes. We expected that participants who were more aware, would procrastinate less on their bedtimes. Secondly, we were interested to find out if short-term or long-term awareness is a better determinant in predicting bedtime procrastination. The expectation was that short-term awareness would be stronger associated with bedtime procrastination than long-term awareness would be. Thirdly, we examined whether a moderating effect of chronotype on these associations would occur, with the expectation that people who tend more to morningness, would be less influenced by these determinants.

Looking at the results, our first two hypotheses can partly be confirmed. The expected association between awareness and bedtime procrastination was only found when looking at the short-term consequences, not when focusing solely on long-term awareness or on awareness in general. In other words: it seems that the intention-behaviour gap described by Sheeran and Webb (2016), was easier overcome when people thought of the consequences

that could be experience the next day than when they thought of the possible long-term health consequences of insufficient sleep. In the self-regulatory dilemma people experience when it is time to go to bed (Kroese, Evers, Adriaanse, & De Ridder, 2014), short-term awareness seems to have made the option of giving in to the temptation of going to bed late less attractive, which resulted in the participants better living up to the intention of going to bed at a certain time. However, being aware of negative health consequences someone could experience on the long run, did not have this effect.

This absence of an association between long-term awareness and bedtime procrastination, is in line with our expectation that the long-term health consequences of insufficient sleep can be seen as a cumulative risk (Slovic, 2000), and therefore could have less, or in our case even no, impact on bedtime procrastination. In a meta-analysis on predictors of health behaviours, Carpenter showed that perceived benefits and barriers, which are elements of the Health Belief Model (Hochbaum, Rosenstock, & Kegels, 1952), are the best predictors of health behaviours (2010). In light of the current study, *perceived benefits* can be defined as the perception someone has on the extent to which going to bed in time will actually help with decreasing the chances of experiencing the negative health outcomes of insufficient sleep in the future. The *perceived barriers* on the other hand, are the costs someone expects to experience due to missing that extra time in the evening, for example missing that one episode on Netflix.

These two predictors can be linked to the self-regulatory dilemma people face when it is time to go to bed (Kroese, Evers, Adriaanse, & de Ridder, 2014). When the perceived benefits are high, because people perceive a decrease in negative health outcomes as a consequence of going to bed on the intended time, going to bed in time will become a more attractive option and less is asked from their self-regulatory skills. Short-term consequences probably result in higher perceived benefits than the long-term health consequences do, because people expect that going to bed later than intended will actually result in being sleepy the next day, while they perceive the chance that this action will result in the more abstract, long-term health consequences much lower, due to the cumulative character of these risks (Slovic, 2000).

Besides this cumulative character of the long-term consequences, the difference in the estimations people make on how likely it is they will experience certain health consequences, can be explained in another way. Like Mullington and colleagues stated, and what was also found in the current study, short-term consequences of insufficient sleep are far better known than the long-term health consequences (2009). This is probably the case because most

people have experienced some of the short-term consequences themselves. Almost everyone can remember a day in which they did not have energy because of a bad night of sleep, which would also explain why the participants in the current study were most aware of this specific health consequence. Having experienced such a consequence for yourself automatically raises the expectation of experiencing it again, due to the *availability bias* (Kahneman, 2011). According to this bias, people perceive the likelihood of a certain event happening much higher when examples of such an event come easily to mind. This could explain the finding that awareness of short-term and not long-term consequences was associated with bedtime procrastination, because short-term consequences come to mind more easily due to personal experience, which results in higher estimations of the chance of experiencing these consequences again, while the perceived chances of experiencing the long-term consequences are estimated even lower due to the cumulative character.

Besides the perceived benefits, the perception of the barriers occurring when going to bed at the intended time, should be a predictor of bedtime procrastination according to Carpenter (2010). This could explain why awareness in general did not predict bedtime procrastination in the current study. Perceived barriers were not measured in the current study, which could mean that they have confounded the association between awareness of the health consequences and bedtime procrastination. Even though someone perceives the benefits of going to bed on time as really useful in preventing the negative health outcomes of insufficient sleep from happening, the advantages of having that extra time in the evening could just be more important to this person. As Kroese and De Ridder stated, bedtime procrastination is not only a sign of failing self-regulatory skills, it can also be the result of a temporarily setting aside of the intention of going to bed on time (2015). When perceived barriers are high, this could result in more temptation to just "forget" about the healthy intentions for a while. It could therefore be the case that awareness in general actually is associated with bedtime procrastination, but the perceived barriers inhibited this effect.

Another possible confounding variable for not finding an effect of awareness in general, can be found in the period the data for this study was collected, during the COVID19-crisis. According to Kraus and colleagues, for a lot of companies this crisis meant they had to digitalize, and people had to start working at home (Kraus et al., 2020). These developments could have influenced working- and with that waking-hours. When someone was tempted to procrastinate on their bedtimes, it is possible that in a normal situation, the perceived health benefits were perceived as high enough by this person to translate the intention of going to bed in time into the actual behaviour of doing so. However, during the

COVID19-crisis, it is possible that this same person perceives the health consequences as less likely to happen, because of the possibility to also procrastinate on their wake-up time. Bedtime procrastination did not mean insufficient sleep during this period per se. It is possible someone still got enough hours of sleep despite the choice of going to bed later than intended, which makes the perceived health benefits of less influence in this decision than they normally would have had.

There also could be an alternative explanation for the finding that short-term awareness and bedtime procrastination were correlated. Because this is a cross-sectional study, nothing can be said about causality. It could be the case that the found association should actually be interpreted the other way around, meaning that people who procrastinate more, fill in lower probabilities of certain negative health outcomes they could experience because of this. This behaviour could be explained by the *Cognitive Dissonance Theory* (Festinger, 1957). According to this theory, people want to be consistent. If their behaviour is not in line with their attitudes and opinions, one of these have to change. In the current study, this could have resulted in participants changing their opinions on the probability of the short-term consequences, in terms of estimating them to be lower, to make sure their attitudes were in line with their behaviour again.

This effect could have been strengthened by the fact that the participants were just reminded of their behaviour, before starting the section on awareness, because prior to this section, they had to report on the extent to which they procrastinate on their bedtimes. You could argue, however, that if this was the case, this would also be true for long-term consequences, what should have resulted in a significant negative association with bedtime procrastination. Maybe the difference here, is that people probably already have experienced some of the short-term consequences of sleep insufficiency in their own lives, while they have not yet experienced the long-term effects. Really experiencing the consequences could have strengthened the cognitive dissonance, explaining why this effect could have occurred for short-term awareness only.

Our third hypothesis, in which we expected to find a moderating effect of chronotype on the association between awareness and bedtime procrastination, could not be confirmed. Our expectation was that awareness would be more strongly associated with bedtime procrastination among people who tend to eveningness, because the self-regulatory dilemma, described by Kroese and colleagues (2014), would be more present in this group, but this was not the case. Besides the possibility that this moderating effect indeed does not exist, an alternative explanation can again be found in the period the data for this study was collected.

If the self-regulatory dilemma did occur to a less extent than it normally would have, due to more flexibility in sleeping in the next day, the expectation that people who tend more towards eveningness are experiencing this dilemma more than people who tend towards morningness and therefore are stronger affected by being aware of health consequences, no longer holds up. This could have made a moderating effect hard or even impossible to find.

The findings in the current study can be of great theoretical and practical value. Firstly, the finding that awareness explains such a small part of bedtime procrastination, raises the question how useful designing and implementing prevention campaigns aimed at educating the population on health consequences of a lack of sleep really is. Instead, preventions could focus on actually giving people the tools to translate their intentions into behaviour for example. Awareness alone does not cause different behaviour. According to a meta-analysis on fear appeals, targeting fear responses, or raising awareness concerning negative health outcomes, works much better when the self-efficacy of the target group was also raised (Tannenbaum et al., 2015). This can be realized by giving practical tips in how to actually go to bed at the intended time.

This could also be relevant considering the finding that chronotype was strongly associated with bedtime procrastination. Instead of treating a tendency to eveningness as an insurmountable inconvenience, prevention designers could think of ways to help these people overcome this biological urge of going to bed late. However, more research is needed when it comes to overcoming the intention-behaviour gap in bedtime procrastination, before it can be implemented in the form of prevention programs. When designers of prevention programs do decide to focus on awareness of health consequences however, which can still be a useful given the finding that short-term awareness and bedtime procrastination actually were associated, prevention campaigns should focus on short-term consequences, because long-term consequences, no matter how severe, do not seem to have an effect on the actual behaviour of people.

As mentioned before, more research is needed before practical tips on how to translate the intention of going to bed in time into the actual behaviour, can be implemented in prevention programs. Future studies could focus on improving the skills of people in closing this gap, for example by studying the applicability of implementation intentions to bedtime procrastination. Gollwitzer described *implementation intentions* as a plan in the form of “If I encounter situation X, I will perform the goal-directed behaviour Y” (Gollwitzer, 1999). Such a plan links a situational cue, for example when the clock says it is 11:00 pm, with the desired behavioral reaction, for example get up from the couch, brush your teeth and go to

bed. Implementation intentions were already shown to be effective in academic procrastinating in a study of Owens, Bowman and Dill (2008), in which participants who formed an implementation intentions were eight times as likely to realize their intentions, than those who did not. Investigating whether this technique could also help in translating the intention of going to bed at a certain time in actually doing it, would be interesting.

Another idea for future researchers is to investigate whether increasing awareness is helpful in tackling bedtime procrastination in an experimental design, in order to establish causality. As mentioned before, the current study was cross-sectional, so it is possible that the found association between short-term awareness and bedtime procrastination actually exists in the opposite direction. Therefore, it could be interesting to find out if a study in which participants are exposed to the possible short-term consequences of insufficient sleep procrastinate less on their bedtimes in the weeks that follow on that exposure than participants who are not. A third condition could consist of a combination of exposure to the consequences and practical tips, like forming an implementation intention (Gollwitzer, 1999), which should have the biggest influence on bedtime procrastination according to the meta-analysis of Tannenbaum and colleagues, because then awareness as well as self-efficacy is raised (2015).

Besides the various theoretical and practical implications of this study, a strength of the current study can be found in the variance in the demographics of the participants. Even though most participants were highly educated, age and gender showed a good variance, which increases the external validity of this study. Another strength of this study is that the data was collected online. Participants often tend to give socially desirable answers when an interviewer is present (Grimm, 2010). In the current study, participants could fill in the questionnaire completely anonymous without an interviewer present, which decreased social desirability bias and raised internal validity.

However, the results of this study should be interpreted with caution. Besides the earlier mentioned limitation of the cross-sectional design, which means that no comments can be made about causality, we should keep in mind that the self-report measures that were used to measure bedtime procrastination, are not always reliable. Subjective self-report measures of sleep quality are not always corresponding with the objective measures of someone’s sleep quality (Unruh et al., 2008), so it could be possible that the measures of bedtime procrastination do not fully match the actual extent to which the participants procrastinated on their bedtimes. Lastly, as we also mentioned before, the data collection was done during the COVID-19 crisis, which could have influenced the results. Besides the possibility that

people had more flexible working times (Kraus et al., 2020), their sleep quality could also have been influenced, due to differences in stress levels and the amount of stimuli people experience during the day (Herter, 2020). Maybe if this study was replicated when this crisis is over, other results would be found, so cautiousness is needed when generalizing these outcomes to the population.

In conclusion, despite these limitations, the current study showed again the importance of getting more in-depth knowledge in factors that could influence bedtime procrastination. In our sample, a substantial part of the participants regularly procrastinated on their bedtimes, which can cause several negative health-outcomes, short- as well as long-term. Awareness of these health-outcomes can be targeted, but the focus should be on short-term consequences. However, since only a small part of the variance in bedtime procrastination can be explained by awareness, future research should also focus on the remaining predictors, for example at how to make people resist urges and temptations and actually change their behaviour, which may also be combined with targeting awareness. The emerging interest in the field of bedtime procrastination is promising, because improving sleep behaviours in the population will eventually lead to various positive health outcomes, which is beneficial for all individuals, as well as for society.

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Appendix. Questionnaire Sleep Behaviour

Demographic information

- What is your age? …
- To which sex do you identify mostly?
    - Male
    - Female
    - Other
    - Prefer not to say
- What is your highest level of education?
    - None
    - Elementary school
    - Secondary school
    - Vocational education
    - Bachelor's degree
    - Masters' degree
    - Doctoral
    - Not listed: …
- Are you diagnosed with a sleeping disorder?
    - Yes
    - No
- Are you working night-shifts?
    - Yes
    - No

Bedtime procrastination

For each of the following statements, please decide whether it applies to you using a scale from 1 (almost) never to 5 (almost) always. Base your answers on your behaviour during the past two weeks.

1. I go to bed later than I had intended.
2. I go to bed early if I have to get up early in the morning (R).
3. If it is time to turn off the lights at night I do it immediately (R).
4. Often I am still doing other things when it is time to go to bed.

5. I easily get distracted by things when I actually would like to go to bed.
6. I do not go to bed on time.
7. I have a regular bedtime which I keep to (R).
8. I want to go to bed on time, but I just don't.
9. I can easily stop with my activities when it is time to go to bed (R).

Awareness

When you don't get enough sleep, which consequences do you think you will experience? For each of the following statements, please decide whether you agree using a scale from 1 strongly disagree to 5 strongly agree.

If I don't get enough sleep, it can cause me to:

1. Feel sleepy during the next day (S)
2. Fall asleep while driving (S)
3. Gain weight (L)
4. Develop heart disease (L)
5. Raise cholesterol (L)
6. Develop hypertension (high blood pressure) (L)
7. Be more moody the next day (S)
8. Have less energy the next day (S)
9. Have a lower sex drive (S)
10. Miss more days of work or school (L)
11. Perform worse at work or school (L)
12. Have problems remembering things or concentrating the next day (S)
13. Develop diabetes (L)
14. Feel tired the next day (S)

Chronotype

1. What time would you get up if you were entirely free to plan your day?
    - 5:00 – 6:29 am (5)
    - 6:30 – 7:44 am (4)
    - 7:45 – 9:44 am (3)
    - 9:45 – 10:59 am (2)

- 11:00 – 11:59 am (1)
- Midday – 5:00 pm (0)

2. What time would you go to bed if you were entirely free to plan your evening?

- 8:00 – 8:59 pm (5)
- 9:00 – 10:14 pm (4)
- 10:15 pm – 12:29 am (3)
- 12:30 – 1:44 am (2)
- 1:45 – 2:59 am (1)
- 3:00 – 8:00 am (0)

3. If there is a specific time at which you have to get up in the morning, to what extent do you depend on being woken up by an alarm clock?

- Not at all dependent (4)
- Slightly dependent (3)
- Fairly dependent (2)
- Very dependent (1)

4. How easy do you find it to get up in the morning (when you are not woken up unexpectedly)?

- Not at all easy (1)
- Not very easy (2)
- Fairly easy (3)
- Very easy (4)

5. How alert do you feel during the first half hour after you wake up in the morning?

- Not at all alert (1)
- Slightly alert (2)
- Fairly alert (3)
- Very alert (4)

6. How hungry do you feel during the first half hour after you wake up in the morning?

- Not at all hungry (1)
- Slightly hungry (2)

- Fairly hungry (3)
- Very hungry (4)

7. During the first half hour after you wake up in the morning, how tired do you feel?

- Very tired (1)
- Fairly tired (2)
- Fairly refreshed (3)
- Very refreshed (4)

8. If you have no commitment the next day, what time would you go to bed compared to your usual bedtime?

- Seldom or never later (4)
- Less than one hour later (3)
- 1-2 hours later (2)
- More than two hours later (1)

9. You have decided to engage in some physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him/her is between 7:00 – 8:00 am. Bearing in mind nothing but your own internal "clock", how do you think you would perform?

- Would be in good form (4)
- Would be in reasonable form (3)
- Would find it difficult (2)
- Would find it very difficult (1)

10. At what time of day do you feel you become tired as a result of need for sleep?

- 8:00 – 8:59 pm (5)
- 9:00 – 10:14 pm (4)
- 10:15 pm – 12:44 am (3)
- 12:45 – 1:59 am (2)
- 2:00 – 3:00 am (1)

11. You want to be at your peak performance for a test that you know is going to be mentally exhausting and will last for two hours. You are entirely free to plan your day. Considering only your own internal "clock", which ONE of the four testing times would you choose?

- 8:00 – 10:00 am (4)
- 11:00 am – 1:00 pm (3)
- 3:00 – 5:00 pm (2)
- 7.00 – 9.00 pm (1)

12. If you got into bed at 11:00 pm, how tired would you be?

- Not at all tired (1)
- A little tired (2)
- Fairly tired (3)
- Very tired (4)

13. For some reason, you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which ONE of the following are you most likely to do?

- Will wake up at usual time and will NOT fall back asleep (4)
- Will wake up at usual time and will doze thereafter (3)
- Will wake up at usual time, but will fall asleep again (2)
- Will NOT wake up until later than usual (1)

14. One night you have to remain awake between 4:00 – 6:00 am in order to carry out a night watch. You have no commitments the next day. Which ONE of the alternatives will suite you best?

- Would NOT go to bed until watch was over (1)
- Would take a nap before and sleep after (2)
- Would take a good sleep before and nap after (3)
- Would sleep only before watch (4)

15. You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own internal “clock” which ONE of the following times would you choose?

- 8.00 – 10.00 am (4)
- 11.00 am – 1.00 pm (3)
- 3.00 – 5.00 pm (2)
- 7.00 – 9.00 pm (1)

16. You have decided to engage in hard physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him/her is between 10:00 – 11:00 pm. Bearing in mind nothing else but your own internal "clock", how well do you think you would perform?

- Would be in good form (1)
- Would be in reasonable form (2)
- Would find it difficult (3)
- Would find it very difficult (4)

17. Suppose that you can choose your school hours. Assume that you went to school for five hours per day and that school was interesting and enjoyable. Which five consecutive hours would you select?

- 5 hours starting between 4.00 – 7.59 am (5)
- 5 hours starting between 8.00 – 8.59 am (4)
- 5 hours starting between 9.00 am – 1.59 pm (3)
- 5 hours starting between 2.00 – 4.59 pm (2)
- 5 hours starting between 5.00 pm – 3.59 am (1)

18. At what time of the day do you think that you reach your "feeling best" peak?

- 5.00 – 7.59 am (5)
- 8.00 – 9.59 am (4)
- 10.00am – 4.59 pm (3)
- 5.00 – 9.59 pm (2)
- 10.00 pm – 4.59 am (1)

19. One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be?

- Definite a "morning" type (6)
- Rather more a "morning" type than an "evening" type (4)
- Rather more an "evening" type than a "morning" type (2)
- Definitely an "evening" type (0)