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Does hitting the snooze-button effect your mood?

Comparing self-reported mood in snoozers and non-snoozers

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Abstract

Snoozing have been a commonly used wake up method since the 1950's and most people seem to have their own opinion whether it is good or bad, but there is no clear reason for its existence or how it affect our emotional processes. Therefore**,** the purpose of this study was to examine snoozers vs non-snoozers mood when sleep inertia is guaranteed (when waking up) and after sleep inertia has dissipated (one hour after having woken up). This was done by comparing the differences in positive and negative affective scores (PANAS) in participants (N=69) with the use of two separate Independent Samples t-tests. One for the differences in positive affective scores and one for the differences in negative affective scores. Higher values reflected increased affective scores. The result indicated that snoozers had increased positive affect scores compared to non-snoozers, whilst there was no observed difference in NA scores. Therefore, we conclude that the participants who snoozed had higher increase in mood compared to non-snoozers. This is the first study that examines snoozing's effect on mood, and hopefully future studies can help us gain better insights by using larger sample sizes, better research designs and by using an instrument with better psychometric properties.

Keywords: Snooze, PANAS, sleep inertia, sleep-wake transition, wake up method

Does hitting the snooze-button effect your mood?

A new field of science has emerged over the past years that has examined how emotional processes in the human brain gets affected by sleep (Ben Simons et al., 2020). The most studied phenomenon in sleep is related to sleep loss. Loss of sleep can emerge from various reasons, such as from neurological or sleep disorders, sleep restrictions, disrupted sleep or total sleep deprivation. Sleep research up until 2009 was mostly focused on characteristic behavioural irregularities after sleep loss, with little focus on our emotions (Mattingly et al., 2022; Walker, 2009). In recent years, a variety of scientists has examined the role of sleep in relation to our emotional processes (Ben Simons et al., 2020). We know that sleep seem to have a restorative effect on the brain, which includes emotional processes (Klemm, 2011). We also know that sleep loss results in an increase of self-reported negative mood and a decreased positive mood (Zhang et al., 2021), and that lack of sleep seem to impair the brains' ability to regulate and express emotions (Goldstein & Walker, 2014). Other studies have observed a bi-directional relationship between our emotional processes and sleep (Goldstein & Walker, 2014). As an example, our mood can affect how we sleep, and our sleep can affect our mood. But research on different ways to wake up and how it may affect our emotional processes is still at its infancy. We have observed that the brain has some type of wake-up process that makes it easier to wake up by reducing morning tiredness (Dettenborn et al., 2007). But studies up until today have mainly had their attention on conditions such as waking up naturally without any external help (such as, Malloggi et al., 2022; Matsuura & Hayashi, 2002), but we do not know how other ways to wake up after a full night of sleep affect our mood.

When waking up, most of us use an alarm clock. Usually with the use of our phone or an external alarm clock. Regardless of what type of device, these alarm clocks usually have three functions, to show the time, to set a fixed time for the alarm to go off, and a snooze-function. You can set one or multiple alarms the night before going to bed, and the snooze-function pauses the current alarm by turning it off and on again, with a 5–10-minute interval. The Snooze-Alarm Clock was first invented in 1956 when General Electric-Telechron released their Model 7H241 "Snooz-Alarm" (Stare, 2022). The first alarm clocks specifically had 9-minute intervals between snoozes but the reason for this very precise time is still unclear. Some debate that these 9-minute snooze-sessions could have been the easiest and cheapest way to design such a function (Stare, 2022). In 1959, Westclox released their version of the Snooze-Alarm called the "Drowse Alarm", which had two snooze-settings. The designers put a rocker bar on the top of the clock, if pushed towards one side you would set a 5-minute snooze, and if pushed the other side, you would set a <10-minute snooze. However, in the 1960's, with the introduction of "flip-digital" clocks, the 5-minute snooze got removed because of how unpopular it was. The snooze-norm was by that time 9 minutes and the multiple choice for snoozing got removed because one snooze-function was cheaper and easier to manufacture. When looking at our current devices in the year 2022, iPhone, Android and external alarm clocks still has the pre-set time of either 5 or 10-minute on their snooze-function. Some now argue that a <10-minute snooze session is considered enough time for a brief rest and if you sleep for more than 10-minutes, you will fall back into deep sleep, which makes waking up harder and more unpleasant (Laliberte & Jones, 2021).

Most people have their own opinion whether snoozing is good or bad, but studies that have examined this phenomenon are closed to none. Mattingly et al. (2022), are seemingly the only once that has examined the snoozing phenomenon. They specifically question the many sleep scientists and the medical professional's discouragement of snoozing, when it is still unknown whether it is bad or not. In their study, they tried to examine who, when, how and why snoozing occurred with a sample of 450 participants. In addition, they also looked for physiological effects of snoozing by measuring heart rate over time. The results showed that 57% of their participants snoozed. They also saw that snoozing behaviour was associated with increased heart rate which indicated lighter sleep before waking up, resulting in less morning tiredness, as well as both trait and state factors that was influenced by demographic and behavioural traits. As an example, their findings suggest that being younger, female, having more disturbed sleep, having lower conscientiousness and being more of a night owl (evening chronotype), increase the likelihood of using snoozing as a method of waking up. But that is all we currently know about the snoozing phenomena.

So, in short, we have since the 1950's been using a wake up-method that have no clear reason for its existence, without any clear explanation to its 5–10-minute intervals or how it may affect us. When browsing through articles on emotional processes and the sleep-wake transition, a lot of attention seem to be aimed towards subjective mood changes (such as, Caldwell & Caldwell, 1998; Ru et al., 2019; Daiss et al., 1986; Hayashi et al., 2005; Hayashi et al., 1999; Zhao et al., 2010). Therefore, we will measure mood when comparing snoozers and non-snoozers to see if there is a difference between these conditions.

Theoretical background

Before continuing, a brief introduction of the terminology commonly used in sleep and mood studies is needed. Starting off by going through the terms; *mood*, *emotion* and *affect*. *Mood* and *emotion* are both subjective feeling states that can be pleasant or unpleasant (positive or negative) and those feelings reflect what is happening within a person (Gray & Watson, 2007). *Mood* and *emotion* are believed to have some shared components that are controlled by similar processes. Because of these similarities, researchers often use a more general label; *affect*. *Affect* stands for a broader, more inclusive psychological construct that refer to a mental state involving evaluation of feelings. In other words, a person's internal evaluation in which he or she feels good/bad or likes/dislikes what is happening to them. In summary, *affect* will be used to describe the evaluation of feelings, *mood* will be used to describe a longer duration of low intense feeling states whilst *emotion* will describe a short-lived intense feeling state (Gray & Watson, 2007).

Mattingly et al. (2022) defines *snoozing* as waking to an alarm after an initial alarm has already generated some degree of alertness, which includes people who only sets one alarm and uses the snooze button, and people who sets two or multiple alarms with the intention of waking up between or at the last alarm. *Non-snoozing* are defined as waking up by only using one alarm with the intention to reach full alertness.

Another commonly used term in sleep research is *nocturnal sleep*, this term describes the typical major sleep episode related to the circadian rhythm, in other words, the typical full night of sleep. *Sleep-wake transition* or *Sleep-to-wake transition* will be used to describe the process of a person going from a sleeping state to an awakened state.

There will also be a lot of different terms describing *sleep loss*. Participants who have had a loss of sleep is commonly described as being *sleep deprived*. But it is also common to describe the same condition as being under a *sleep restriction*. All these terms describe participants who have had restricted nocturnal sleep, who have been deprived of sleep resulting in sleep loss.

Mood

Many scientists throughout the years have tried to conceptualize the complexity of emotion. Two of the most commonly used theories are Ekman's (1992) Theory of basic emotions and Russell's (1980) Circumplex model of emotion. The theory of basic emotion proposes the existence of a fixed set of emotional categories, including joy, sadness, fear, anger, disgust, and surprise (Ekman, 1992). The limitation of this theory is that is proposes a narrow scope of emotions (Jaso, 2021). One of the arguments that supports this proposed limitation is that the English language alone has 600 words for specific emotional states, where six categories is seen as an oversimplification and not fully able to contain all those emotional experiences. This is assumed to be a problem in all languages.

The Dimensional theory of emotion is instead reliant on two dimensions containing a wider range of emotions (Jaso, 2021). From this theory, the Circumplex model was developed (Russell, 1980). This model included categories of emotions based on valance (positive or negative) and arousal (activated or deactivated). The dimensional theory does not require participants to identify and differentiate between specific emotions in the same way that the Theory of basic emotions do. However, the many instruments that measure valance and arousal often use adjectives that needs to be carefully translated to not compromise its validity (Jaso, 2021). There are according to Russell and Barrett (1999) no easy answer to what type of approach one should have to research emotions, but there are a few ways to narrow the choices.

When doing research on mood, we need to consider if we want to measure state or trait affect (Gray & Watson, 2007). State affect are defined as the experience of moods or emotions that requires participants to rate how they are feeling right now in that moment. Trait affect, on the other hand, refers to a person's long-term, stable individual differences. Because this thesis aims to investigate participants mood after having woken up, a state measurement with questions of how they feel right at that moment is deemed most appropriate.

Then we need to find a model that measures mood. In order to find an appropriate instrument, we need to find a model that capture the key constructs within the thing we want to measure (Gray & Watson, 2007). There are two primary models that are commonly used in mood studies, one that involves specific-affect models and one that involves dimensional models. These models are based on the two emotional theories mentioned earlier (the Theory of basic emotions and the Dimensional theory). Because this study is focused on mood, which is described as a general feeling state compared to specific emotions (such as joy, sadness, and anger), a dimensional model is deemed more appropriate for this study.

When looking back at early research on participants affective experiences, the majority of researchers adopted discrete emotion models instead of dimensional models (such as Beck et al., 1961; Zuckerman & Lubin, 1965). However, the problem was that some of these basic emotions and moods had high correlation with each other (Gray & Watson, 2007). When participants were rating themselves as anxious, they also reported experiencing other negative emotions, such as sadness and hostility. Therefore, we will continue searching for newer models using the dimensional approach to better be able to capture our participant's affective experience.

The dimensional theories started to emerge around the 1980's (Gray & Watson, 2007). One of the models that was developed was Russell's (1980) Circumplex model. This model included two bipolar dimensions where variables can be systematically positioned around the perimeter of a circle. The two dimensions were *Pleasure-Displeasure* and *Arousal-Sleep*. Watson and Tellegen (1985) later developed two new dimensions of affect that also could be arranged in a circumplex. The two dimensions were *high and low Positive* Affect and *high and low Negative Affect*.

Russell's (1980) and Watson and Tellegen's (1985) models differed in the way they had opposing views on the polarity of the dimensions. Russell's (1980) model emphasized the bipolarity of affect, where pleasant (e.g., happy and satisfied) and unhappy (e.g., sad and gloomy) states was on opposite ends of the same dimension (Gray & Watson, 2007). This created a bipolar continuum of positive versus negative feelings. Watson's and Tellegen's (1985) model instead focused on two independent and unipolar dimensions of affective space, including Positive Affects (e.g., the degree of feeling cheerfulness and enthusiasm) and Negative Affects (e.g., the degree of feeling fear, anger, guilt, and disgust). These two models have been empirically tested throughout the years and have both proved to be reliable ways of measure affect using the dimensional approach. Therefore, newer models that measure mood are often based on these two structures.

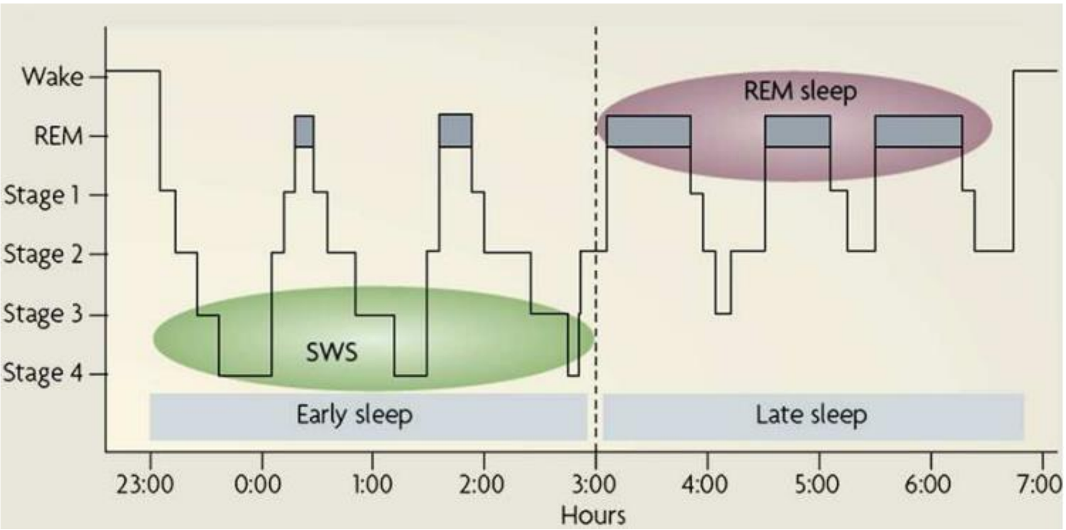
One of these new models as well as one of the most common ways to measure mood is the Positive and Negative Affect Schedule (PANAS), developed by Watson et al. (1988). PANAS is considered a quick, easy and effective way of assessing positive and negative affect. PANAS has been proven to be psychometrically superior to the previous adjective checklists and was considered the most used measurement of mood in 2007 (Gray & Watson, 2007). This model is deemed an appropriate way to measure mood and will therefore be used in this thesis. However, this thesis will use the translated Swedish version of PANAS previously used in Garcia et al. (2016), Garcia (2014), and Garcia and Erlandsson (2011).

Sleep

According to Klemm (2011), sleep is required for restorative means. Basically, sleep is required to restore the brains complex nerve impulse patterns in the neuronal network that is necessary to re-create and to sustain our wakeful state. But what parts of the brain gets affected and how is this associated with our emotional processes? In an attempt to answer this, we will start off with a review of research on sleep and how it is associated with different emotional processes.

We do know that one-third of a person's life is spent sleeping (Payne, 2011). Even though sleep is something obvious to us all, there are still many things about it that remains a mystery. So far this is what we know; during nocturnal sleep, we continuously go through 90-minute cycles with five different sleep stages (Payne, 2011). There are two types of sleep stages, non-rapid eye sleep (NREM) and rapid eye movement sleep (REM). NREM sleep consists of sleep stage one (N1), two (N2), three (N3) and four (N4), whilst REM has no stages. These types of sleep stages can be monitored with the use of an electroencephalogram (EEG). These stages can also be divided into two different categorize, slow wave sleep (SWS) and light wave sleep (LWS). SWS consists of N3 and N4, and is considered deep sleep. LWS consists of N1, N2 and REM and is considered as light sleep. Payne (2011) observed that the first half of a nocturnal sleep contains more than 80% of SWS, whilst the last half contains twice as much REM sleep.

Figure 1. A sleep histogram showing the distribution of SWS and REM sleep during nocturnal sleep (Klemm, 2011)



As demonstrated in Figure 1, successive cycles during nocturnal sleep reduce N3 and N4, and favours N1, N2 and REM. In other words, the first half of the night the SWS is more prominent, whilst REM and LWS is more prominent during the last half (Klemm, 2011). It is during REM sleep that activity in emotional brain regions such as the amygdala, striatum, hippocampus, insula and medial prefrontal cortex (mPFC) increases (Goldstein & Walker, 2014).

Sleep loss

In order to find different ways that sleep affects our emotional processes, many researchers have studied sleep loss and its impact on our emotional brain. A sleep loss state can be achieved if you sleep less than the normal 7-8 hours during nocturnal sleep. Generally, the findings in 2014 suggest a casual role for sleep in order to achieve optimal regulation of the brain's affective functions (Goldstein & Walker, 2014).

Yoo et al. (2007), Gujar et al. (2011) and Motomura et al. (2013) observed increased reactivity in the amygdala and a significant loss of functional connectivity between the amygdala and the mPFC in sleep deprived participants. This reactivity and loss of functional connectivity are assumed to compromise individuals' ability to accurately evaluate emotional experiences. It is also during REM sleep that the concentrations of noradrenaline (norepinephrine) get significantly reduced (Goldstein & Walker, 2014). Noradrenaline is associated with many arousal-related emotional processes within both the brain and body. A disfunction in the secretion of noradrenaline is associated with psychopathologies such as major depression and PTSD.

Other studies using subjective reports on sleep deprived participants have reported similar results. Sleep deprived participants had increased emotional difficulties (Dinges et al., 1997), increased irritability and emotional volatility (Horne, 1985), increased impulsivity towards negative stimuli, as well as increased stress, anxiety and anger in response to low stress situations (Minkel et al., 2012). Sleep loss also seems to trigger a state where rewards are overvalued (Goldstein & Walker, 2014). This suggest that individuals' who are sleep deprived are more susceptible to overeat because of increased appetite and increased preference for higher calorie foods (Benedict et al., 2013; Greer et al., 2013; Killgore et al., 2013; St-Onge et al., 2012).

It is not only the evaluation of emotions that gets affected by sleep loss, but also the ability to recognise and express emotions (Goldstein & Walker, 2014). Van der Helm et al. (2010) saw a blunting effect in the subjective rating in emotion intensity of threat (angry) and reward-relevant (happy) facial expressions. Sleep loss also seem to decrease the outward expression of emotion (Minkel et al., 2011), as well as slow down the generation of facial reactions in response to visual stimuli (Schwarz et al., 2013). Sleep also seems to play an influential role in the way we modulate conditioned fear (Goldstein & Walkman, 2014). Healthy participants with enough sleep showed improved next-day sensitivity to discriminate between threatening and non-threatening stimuli compared to sleep deprived participants (Phelps et al., 2004; Menz et al., 2013). This suggest that sleep and how we interpret fear is associated, and that interpretation of fear effects how we experience fearful situations.

Even though the research on the restorative functionality of sleep on emotion is considered somewhat lacking (Goldstein & Walker, 2014), the current research seems to suggest that loss of sleep actually do affect the restoration of some emotional processes. Goldstein and Walker (2014) therefore conclude that there seem to be a bi-directional relationship between sleep and the brains emotional functions. A lack of sleep hinders the brains' ability to appropriately regulate and express emotions, both in the brain and behaviour, which seems to modulate emotional processes on both the arousal and the valance dimensions. From these findings, we know that a full night of sleep is required to avoid compromising the restoration of emotional processes in the brain. It is also important to point out that there are no indications that the sleep-to-awake transition impacts any of these processes. This assumption is based on the fact that the wake-up process is at the absolute end of the nocturnal sleep, and it is therefore unlikely that it causes any disturbances.

Sleep-wake transition

It has been observed that the latter REM cycles increases the stress hormone cortisol levels (Dettenborn et al., 2007). This secretion of cortisol, commonly referred as the Cortisol Awakening Response (CAR), is believed to have a function to ease the wake-up process though increased heart rate, reduced SWS and increased LWS (Mattingly et al., 2022; Dettenborn et al., 2007; Malloggi et al., 2022). CAR describes the 50-60 % increased secretion of the stress hormone cortisol that are produced by the Hypothalamus-Pituitary-Adrenal axis (HPA-axis) before waking up (Dettenborn et al., 2007). In general, people with a normal sleep-wake cycle have circadian peaking levels of cortisol 30 minutes after waking up, which lasts about 1 hour, then decreases during the day. However, Matsuura and Hayashi (2009) observed that participants who was instructed to wake up on their own had elevated CAR activity approximately 1 hour before waking up, whilst participants with forced awakening conditions showed no such activation. Therefore, it can be assumed that CAR is triggered in participants with the intention to self-awake at a certain time, without any consequences to the nocturnal sleep processes (Malloggi et al., 2021).

When a person reacts to a stressor, the sympathetic nervous system gets activated and the adrenal glands starts releasing cortisol that increase heart rate, blood pressure and supplying blood sugar, which results in a burst of energy (Ciccarelli & White, 2018). This type of stress reaction could be triggered by using snoozing as a wake-up method (Mattingly et al., 2022). It is therefore assumed that snoozing could cause similar physiological changes as CAR that favours LWS and decrease SWS. Mattingly et al. (2022) observed elevated heart rate one hour before awakening in participants that snoozed. However, they only measured heart rate, nothing else that could confirm or disconfirm this claim, but these results do bring up some interesting speculations.

Morning tiredness

We have all experienced varieties in the duration of morning tiredness. This common, widely known phenomena have been associated with increased reported depressed mood (Ohayon et al., 2000), impaired activity scheduling (Cuijpers et al., 2007), reduced arousal and impaired cognitive functioning (Trotti, 2017). It has also been observed that people with mood disorders have an increased amount of morning tiredness (Trotti, 2017).

Morning tiredness is in the scientific world known as sleep inertia. Sleep inertia is defined as the physiological state in transition from sleep to wake that is characterized by decreased arousal, impaired performance (physical and mental), and disorientation (Tassi & Muzet, 2000). Sleep inertia is commonly seen after waking from a full habitual night of sleep under well-rested conditions and are therefore seen as an obvious step after the sleep-wake transition (Hilditch et al., 2017). Although there are many articles on the subject, its known effects are not fully explored, nor its duration. We have seen that sleep inertia is a state that can persist between 3 minutes to 4 hours (Tassi et al., 2000; Jewett et al., 1999). However, this wide range of its duration was gathered from both well-rested and sleep deprived participants. In healthy, well rested participants, sleep inertia seems to gradually dissipate within the first hour (Tassi et al., 2000). This phenomenon is sometimes also referred to as “sleep drunkenness” and is thought to have an evolutionary function of indicating that something is wrong with the sleep quality (Trotti, 2017). Sleep inertias duration seems to be affected by; waking up during the nocturnal sleep, prior sleep loss, extended wakefulness, if you wake up during SWS or if the first part of the nocturnal sleep includes an abnormal amount of SWS (Hilditch et al., 2017). Caffeine has also been suggested to reduce the duration of sleep inertia (Newman et al., 2013, Van Dongen et al., 2001). Therefore we assume that it is vital for our participants to be well-rested in order to ensure that sleep inertia dissipates within 1 hour after having woken up.

When searching through articles on sleep inertia, almost all of them included short nap conditions to see if there could be a relationship between nap length and sleep inertia, LWS and sleep inertia and other ways to reduce the duration of sleep inertia. This was considered groundbreaking, mainly because of how similar short naps are compared to snoozing. Short naps are defined as going from an awakened state, to sleep for a short duration, then to wake up again. And just like snoozing, there seem to be a variety in individual’s preference as to who enjoys taking naps and who believes it is bad for them.

Short naps and mood

Caldwell and Caldwell (1998) found significant improved mood in participants who took 2-hour afternoon naps. Ru et al. (2019) observed subtle benefits to subjective mood in their participants after a midday 30–40-minute nap whilst highlighting the need for more studies before conclusions can be made. Some studies saw different results, such as Hayashi et al (1999), who saw no improvement in mood in their participants after a 20-minute afternoon nap and suggested that mood was unaffected by the nap intervention. Even more interesting, Daiss et al. (1986) saw improved mood regardless if their participants actually slept during the nap, or if they only rested. Another study made by Hayashi et al. (2005) measured subjective mood when waking up after a nap. They mention the restorative effects of sleep, which implies the same approach as the restorative theory. Their results suggests that short naps of 5- to 10,2-minutes sleep leads to improved subjective mood, regardless if the participants woke up during N1 or N2 (Hayashi et al., 2005). However, the study measured sleepiness and fatigue to collect their subjective mood ratings, but they lack an explanation and references to how and why they chose to measure mood in this way. The same way of measuring mood is seen in studies such as Hayashi et al's (1999) and Zhao et al's (2010), but they also include motivation as a variable. They all mention the use of visual analog scale (VAS) when they measure mood, but all without an explanation as to why they chose this measurement. Literature on differences between VAS and models using the arousal and valance dimensions is next to none. The only article that was found is a non-peer-reviewed article published at the University of Miami (Jaso, 2021). VAS is described as a way to measure emotions through the use of the categorical approach. In other words, a VAS was constructed using a belief of the existence of a fixed set of basic emotions rather than the dimensional approach used in this thesis. Jaso (2021) article compare the categorical emotions (VAS) to the dimensional approach (Circumplex Affect Grid). The conclusions were that the dimensional approach more accurately capture emotional experiences, especially when measuring mood throughout participants day.

So, there seem to be mixed results whether or not short naps affects mood, but most of them suggest improved mood after taking a nap, seemingly regardless of nap length and type of measurement. These mixed results highlight the need for further investigation to see if short amounts of sleep really do affect our mood.

Length of short naps

Now we have some indication that supports the idea that short naps improve our mood in participants waking up whilst in N1 and N2 (Hayashi et al.,2005). Naps that are less than 30 minutes have since many years been considered a method to avoid sleep inertia, mainly because it takes approximately 30 minutes after sleep onset before SWS begins (Hilditch et al., 2017). However, these findings are based on studies that have been conducted during the day (Tietzel & Lack, 2001; Brooks & Lack, 2006; Tietzel & Lack, 2002). Hilditch et al's (2017) meta-analysis therefore sought to examine exactly how long naps can be in order to avoid sleep inertia and the relationship between SWS and sleep inertia.

SWS usually occurs 30 minutes after the onset of a habitual nocturnal sleep (Gillberg & Åkerstedt, 1991). However, previous research on short daytime naps saw different results. Only short naps of 10 minutes were association with absent sleep inertia (Hilditch et al., 2017), but this absents of sleep inertia only seems to work on well-rested participants. Previous research conducted by Hilditch et al. (2015) observed that a 10-minute nap after a simulated night shift (including an extended wakefulness condition) was associated with sleep inertia. This suggest that a full night of nocturnal sleep could be required to be able to have a 10-minute nap without sleep inertia. It is therefore assumed that any potential disturbances (such as sleep deprivation or extended wakefulness) to the circadian rhythm influences sleep patterns during short naps (Hilditch et al., 2017).

Fushimi and Hayashi (2008) saw in a review of articles on naps and SWS that SWS only was observed in naps longer than 15 minutes, with an average of 5 minutes of SWS in naps between 20 to 30 minutes in well-rested participants. The SWS appeared on an average 18 minutes after onset of N1. The same sleep pattern was observed in participants who only had 4-5 hours of nocturnal sleep when taking 10-minute naps. In summary, there seem to be higher chances of SWS with the increased length of a nap (Hilditch et al., 2017). This is the case in both well-rested and sleep restricted participants. However, the nap duration that is recommended to avoid sleep inertia is <15 minutes instead of the previously believed <30 minutes.

The direct relationship between SWS and sleep inertia in short naps is still discussed because of insufficient data (Hilditch et al., 2017). SWS for short naps may be co-dependent on the naps duration to independently influence performance. Hilditch et al. (2017) highlights the need for more studies that investigates SWS deprivation where participants are awakened by multiple stimulus to try and divert them from going into deeper sleep stages. Which this study aims to do. Although, it must be emphasized that Hilditch et al (2017) also highlights the need for EEG monitoring in addition to a task to be able to draw any further conclusions.

In short, there are studies that supports the idea that SWS increase sleep inertia whilst LWS reduce its duration. There are also studies suggesting that short naps (<10 minutes), which involves a similar sleep-awake transition as when using the snooze-function, decrease the chance of SWS and increase the likelihood of LWS. However, the relationship between improved mood and short naps could be discussed due to methodological differences and mixed results in previous studies. But based on these findings, we assume that 1) sleep inertia might impact self-reported mood in a negative way, 2) short naps (<15-minutes) generates no sleep inertia and this might be because of the decreased chance of SWS and increased likelihood of LWS, 3) Waking up during LWS seems to reduce the effects of sleep inertia.

Research question

There seem to be bi-directional relationship between sleep and our emotional processes (Goldstein & Walker, 2014), together with the assumption that there seem to be a uni-directional relationship between sleep quality and sleep inertia (Hilditch et al., 2017). Sleep quality can affect the duration of sleep inertia but sleep inertia in itself cannot directly affect sleep quality. It was also assumed to be a bi-directional relationship between mood and sleep inertia. People with mood disorders have shown to have increased amount of sleep inertia and sleep inertia affects our mood (Ohayon et al., 2000). Sleep inertia is assumed to get reduced by an activation of CAR and by waking up whilst in LSW (Mattingly et al., 2022). Therefore, it is assumed that continuous snoozing activates CAR, which in turn reduce the chance of going back to SWS and favors LWS, hence, reduces the effects of sleep inertia which in turn reduces bad mood.

The assumption is that CAR activates earlier in habitual snoozers compared to habitual non-snoozers, without being sure as to what degree. We are therefore interested in measuring mood after a full night of nocturnal sleep, first when sleep inertia is guaranteed (the moment they wake up) and when sleep inertia is absent (one hour after having been awakened). By doing this, we can use the divided difference in positive and negative affective scores at these two different occasions to see if there is a difference in mood between snoozers and non-snoozers.

Method

Participants

75 participants were recruited through personal connections and advertisement on Facebook. To be included in the study, the participants had to be over 18 years old, use an alarm to wake up in the morning, without any history of neurological or sleep disorders or any current diagnose of depression. The participants received instructions to conduct the tests after a full night of sleep and not to drink any coffee or alcohol the night before. A total of 6 participants got removed from the results because 4 participants only answered Test 1, and 2 participants only answered the tests without sending in the information page, thus, making it impossible to see what condition they had (snooze or non-snooze). After this removal, there were a total of 69 participants, 37 snoozers and 32 non-snoozers. The sample consisted of 15 females and 54 males, with a mean age of 36.97 (SD=12.90).

Design

A preferred research design would be to conduct a real experiment in a laboratory settings, using both physiological and psychological methods to collect data, but due to the fact that this is a student thesis with a lack of both resources and time, this study will be using a non-experimental design. First of all, this study have no control over the independent variable and rely on participants self-reported ways of waking up and their self-reported mood, without knowing if they really woke up as they have reported, or if they fully have understood the dependent variable (PANAS). An experiment in a laboratory setting could have had better control of the independent variable and enable the possibility to make sure that participants understood the instructions.

Randomization to different conditions was excluded because of ethical reasons. Forcing participants to wake up in conditions they are not used to could cause psychological stress (Moorcroft et al.,1997; Lavie et al., 1979). Another reason for this choice is due to the fact that previous studies have shown that participants who wakes up as they normally do display tendencies to feel subjectively better in the morning compared to those who are forced to wake up in a non-habitual way (Matsuura et al., 2002). Thus endorsing the argument that participants should wake up in their preferred way instead of being forced into different conditions.

Instruments

PANAS includes 10 positive (PA) and 10 negative (NA) adjectives and requires participants to rate to what degree they are currently feeling on the scales 1 (very slightly) to 5 (extremely). These adjectives have then been translated into Swedish.

The Swedish translated PANAS version is based on English adjectives that have shown excellent internal consistency and convergent, and discriminant validity (Watson & Clark, 1997; Watson et al., 1988; Watson et al., 2000).

These 10 PA and 10 NA adjectives has been translated and used in previous research (Garcia et al., 2016; Garcia, 2014; Garcia & Erlandsson, 2011). However, these translated adjectives have not been validated, therefore, we will add a factor analysis on all of the Swedish translated adjectives. The Swedish version was also made to examine participants mood in retrospective, whilst this study will examine their current mood.

Table 1. The 10 translated PA adjectives

Enthusiastic	Entusiastisk
Alert	På alerten
Inspired	Inspirerad
Excited	Ivrig
Determined	Bestämd
Proud	Stolt
Interested	Engagerad
Attentive	Uppmärksam
Active	Aktiv
Strong	Stark

Table 2. The 10 translated NA adjectives

Afraid	Rädd
Scared	Skrämd
Distressed	Förtvivlad
Nervous	Nervös
Jittery	Pirrig, ängslig
Upset	Upprörd
Irritable	Retlig
Guilty	Har skuldkänslor
Ashamed	Skamsen
Hostile	Fientlig

Table 1 and 2 contains the 20 translated adjectives previous used in Swedish studies adjusted to present tense. When browsing through the studies that have used the Swedish translated version of PANAS (Garcia et al., 2016; Garcia, 2014; Garcia & Erlandsson, 2011), there were no described method as to how they came up with these translated adjectives or how well they correlate with the English adjectives. By running two separate Exploratory Factor Analysis, one for Test 1 and one for Test 2, we can see if the factor loadings shows similar factor loadings compared to the original English version. In addition to this, we will also conduct two separate Cronbach's alpha reliability tests of the items to get a better understanding of the internal consistency.

Exploratory Factor Analysis for PA and NA

We began with running an Exploratory Factor Analysis on Test 1. The analysis retained by using an estimation method of Principal Axis Factoring, and the manual option of choosing two factors with an Oblique (Promax) rotation is seen below.

Table 3. Factor Loadings for PA and NA scores

	Factor 1	Factor 2	Uniqueness
Entusiastisk	0.813	0.001	0.339
Bestämd	0.782	0.189	0.350
Stolt	0.771	0.073	0.400
Inspirerad	0.729	0.006	0.468
Aktiv	0.712	0.034	0.491
Ivrig	0.673	0.066	0.542
På alerten	0.659	0.013	0.565
Stark	0.555	-0.305	0.603
Engagerad	0.548	-0.267	0.631
Uppmärksam	0.429	-0.133	0.800
Förtvivlad	-0.296	0.653	0.489
Har skuldkänslor	0.264	0.407	0.762
Upprörd	-0.240	0.748	0.386
Skamsen	0.225	0.490	0.707
Skrämd	0.073	0.062	0.991
Retlig	-0.068	0.656	0.566
Rädd	0.048	0.251	0.934
Fientlig	-0.046	0.846	0.283
Pirrig, ängslig	-0.046	0.411	0.829
Nervös	-0.006	0.305	0.907

Note. Applied rotation method is promax.

First, we look at the factor loadings uniqueness within the two factors. The PA item Uppmärksam (*r*=429, uniqueness=.800), and the NA items Nervös (*r*=.305, uniqueness=.907), Pirrig, ängslig (*r*=.411, uniqueness=.829), Rädd (*r*=.251, uniqueness=.934), Skrämd (*r*=.062, uniqueness=.991) all have correlations <.5 and a uniqueness >.8.

An additional fit indicates the model had acceptable value of RMSEA (.082) but with a TLI below acceptable values (.794) indicating a bad fit. An RMSEA value of .05 is considered good, whilst .08 suggests a reasonable model-data fit. TLI values >.90 indicates an acceptable fit.

Secondly, a Cronbach's alpha test was conducted on the two factors (PA and NA) items. The Cronbach's alpha for the PA factor (.889) indicates high reliability (>.7) without any indication that the removal of any of the items would make any significant changes. The Cronbach's alpha for the NA factor (.763) also indicates high reliability with no indication that the removal of any items would make any significant changes.

In summary, the model fit could be deemed as questionable because of the items Uppmärksam, Nervös, Pirrig, ängslig, Rädd and Skrämd low correlation and high uniqueness, and with low scores on the TLI. However, a follow up Cronbach's alpha showed high reliability (>.7) in both factors (PA and NA) with no indication that any of the items should be removed.

When looking at Test 2's exploratory factor analysis, we observed some differences in the factor loadings.

Table 4. Factor Loadings for PA and NA scores

	Factor 1	Factor 2	Uniqueness
På alerten	0.796	-0.055	0.379
Entisiastisk	0.778	0.071	0.370
Engagerad	0.774	-0.127	0.419
Inspirerad	0.771	-0.022	0.411
Aktiv	0.767	0.048	0.397
Stolt	0.760	-0.060	0.435
Uppmärksam	0.734	-0.072	0.475
Stark	0.712	-0.273	0.488
Bestämd	0.613	0.009	0.623
Pirrig, ängslig	0.343	0.349	0.718
Fientlig	-0.338	0.424	0.757
Nervös	0.267	0.154	0.890
Har skuldkänslor	0.265	0.379	0.751
Förtvivlad	-0.250	0.711	0.495
Upprörd	-0.232	0.789	0.388
Retlig	-0.162	0.708	0.513
Skamsen	0.129	0.319	0.867
Rädd	0.091	0.103	0.978
Skrämd	-0.051	0.003	0.997
Ivrig	0.032	0.227	0.945

Note. Applied rotation method is promax.

In Test 2, the PA item Ivrig (*r*=.032, uniqueness=.945) and the NA items Skrämd (*r*=.003, uniqueness=.997), Rädd (*r*=.103, uniqueness=.978), Skamsen (*r*=.319, uniqueness=.867) and Nervös (r=.154, uniqueness=.890) all have correlations <.5 and uniqueness >.8.

An additional fit indicated that the model had acceptable value of RMSEA (.108) but with even lower values on TLI (.677).

We also observed some differences in Cronbach's alpha. Starting off with the PA factors items. The PA's Cronbach's alpha (.881) did uphold the satisfactory threshold of >.7, with some indications that the removal of the item Ivrig could increase the Cronbach's alpha to .917. The NA factors Cronbach's alpha (.677) did not reach above .7. Not even the removal of items would make any significant difference.

In summary, the model for Test 2 indicates low reliability due to the items Ivrig, Nervös, Rädd, Skrämd och Skamsen having low correlation and high uniqueness with low scores on the TLI. The Cronbach's alpha for the PA factor indicated high reliability, with some indication that the item Ivrig could be removed to increase the reliability, whilst the NA factors Cronbach's alpha indicates low reliability regardless of the removal of any of the items.

Procedure

The data was collected using Google Forms. There were a total of three separate links to three separate Google Forms, one for the information page, one for Test 1 and one for Test 2. The link to the information page was included in the advertised Facebook post whilst the links to Test 1 and Test 2 could be found both in the advertised Facebook post, and in the information page. A randomized order of the items was used in both tests to avoid systematic bias. Participants enrolled in the survey by clicking on the provided Google Forms link to reach the information page. The information page provided the participants with information about the study and its purpose, instructions, and an everyday example of those instructions. The instructions were as followed:

1. Decide what morning you want to conduct the tests
2. Read, fill, and send in the information page the day before conducting the tests
3. Do not drink coffee nor alcohol the night before the tests
4. Do Test 1(use the hyperlink to get to test 1) directly when you have woken up
5. Do Test 2 (use the hyperlink to get to test 2) after having been awake for one hour

These instructions were included in a try to help the participants to plan beforehand and in doing so, maybe reducing the pressure of conducting the tests. Even though the instructions asked the participants to pick a specific morning to conduct the tests, there was no way of knowing if they actually did snooze or not snooze that specific morning. It was assumed that habitual snoozers or non-snoozers did not change their wake-up methods. Then the participants were asked to pick an anonymous name that would be used to connect their information to the tests. Lastly, they were asked to fill in demographics such as gender, age, where they live, what time they usually goes to sleep and wakes up, if they usually snooze or don't use snooze in the morning, followed by asking for consent to participating in the study. The demographic questions was included only to try and draw attention away from the snoozing vs non-snoozing question. Because the information page included the studies purpose that explicit informed that we wanted to measure how they feel after having had a full night of sleep, no questions about sleep duration was included. No question about snoozing duration was added because modern devices usually have fixed snoozing durations between 5-10 minutes.

On the morning of their choosing, all participants got to Test 1 by using the links provided. The first thing they saw was a short text: "Good morning, this is test 1 that you conduct directly after you have woken up", then asking them to write their anonymous name that they had chosen for themselves in the information page. Then they got to rate their current mood. All participants completed the first test and after completion, they were met with the text "Thank you for your answers, see you again in one hour.".

The same procedure was made at the second test. The only three differences were the short text at the start which was "Hi again, this is test 2 that you conduct one hour after having woken up", the text after completion, which instead was "Now, we are done! Thank you so very much for participating in my study and have a wonderful day", and the order of the items. The results was manually transferred from Google Forms to Microsoft Excel.

Ethics

Even though the information page was written with an intention to draw attention away from the true purpose of the study with the use of distracting demographic questions, it began with explaining that the studies' true purpose. The information page also provided information that they could cancel their participation at any given time, that the data only will be examined on a group level, not individually, that their participation was anonymous, how the study and the university deals with personal data, and lastly, when the study will be published and how to find it. Gender was collected with the use of RFSU's (2016) recommendations with no fixed options so participants could enter their own answers.

Analyses

It was expected that there would be an increase in mood regardless of condition, because of the assumption that sleep inertia is guaranteed at the first test and absent in the second test. Therefore, we included separate Wilcoxon signed-rank tests for both the PA and NA scores to see how much difference there was between the two tests.

In order to see if there is a difference in mood between the snooze vs non-snooze condition, we started off by subtracting PA/NA scores for Test 2 by the PA/NA scores in Test 1. Resulting in one difference in PA and one difference in NA. Higher values equals an increase of PA or NA. By doing this, we minimize the individual differences and remove time, and only look for increased PA or NA between the two conditions (Snoozers vs Non-snoozers). We analyzed this data by using two separate Independent Samples t-tests, one with the difference in PA as the dependent variable and conditions (Snoozers vs Non-snoozers) as the independent variable. The other Independent Samples t-test used difference in NA as the dependent variable and conditions (Snoozers vs Non-snoozers) as the independent variable. Due to the assumption that snoozers could have a higher chance of being in a better mood in the morning, it is expected that there will be a higher increase of PA scores and a decrease of NA scores in snoozers compared to non-snoozers.

Results

PA scores

To see if there was a difference in PA scores between Test 1 and 2 regardless of condition, we started with a Shapiro-Wilk test that was significant, suggesting that the pairwise difference were not normally distributed (W=.964, p=.043), therefore we conducted a Wilcoxon's signed-rank test. A Wilcoxon's signed-rank test showed that the PA scores in Test 1 (M=25.275, SD=7.033) was significantly lower compared to the PA scores in Test 2 (M=35.696, SD=6.958), W= 10.500, p=.001. The rank-biserial correlation (r_B) =.991 suggests that this is a large effect size.

To analyze the difference in PA scores between conditions, we started off with a Levene test that found that the assumption of homogeneity of variance was met: F(1) =.231, p=.632. Shapiro-Wilk test showed that the group Snoozers have normally distributed data: (W=0.948, p=.084), whilst the Non-snooze group had no normally distributed data (W=.933, p=.48). Because of this violation to normality in one of the groups, a comparison between the t-test results and a Mann-Whitney test was performed to see if they gave different results.

An Independent Samples t-test for the difference in PA scores showed significant differences between snoozers and non-snoozers: t (67) = 4.317, p=<.001. Cohens d (.274) suggests that this is a small effect. Snoozers had higher increase in PA (M= 13.541, SD= 6.822) compared to Non-snoozers (M= 6.813 (SD = 6.002). A Mann-Whitney test also showed a significant difference between conditions (p<.001).

NA scores

To see if there was a difference in NA scores between Test 1 and 2, regardless of condition, we performed a Shapiro-Wilk test that was significant, suggesting that the pairwise difference were not normally distributed (*W*=.892, *p*=.001), therefore we conducted a Wilcoxon's signed-rank test. A Wilcoxon's signed-rank test showed that that NA scores in Test 1 (*M*=13.812, *SD*=3.793) was significantly higher compared to the NA scores in Test 2 (*M*=12.000, *SD*=2.668), *W*=1089.500 *p*=.001. The rank-biserial correlation (r_B) =.779 suggests that this is a large effect size.

To analyze the difference in NA scores between conditions, we started off with a Levene test that found that the assumption of homogeneity of variance was met: *F*(1) =.035, *p*=.853. A Shapiro-Wilk test showed that the group Snoozers had normally distributed data: (*W*=.953, *p*=.121), whilst the Non-snooze group had no normally distributed data (*W*=.736, *p*<.001). Therefore, we also compared the t-test results to a Mann-Whitney test to see if they gave different results.

An Independent Samples t-test for the difference in NA scores showed non-significant results (*t* (67) = 1.027, *p*=.308). A Mann-Whitney test also showed no significant difference between conditions (*p*=.057).

Discussion

The purpose of the study was to see if there was a difference between snoozers and non-snoozers when measuring mood. The results showed that the participants who snoozed had significant increased PA scores compared to non-snoozers, but no there was a non-significant difference in NA scores between the two conditions. These results suggest that snoozing leads to better mood compared to using only one alarm to wake up when measuring participants with and without the effects of sleep inertia.

These findings could be interpreted as supporting our assumption that snoozing activates the CAR through multiple sleep-wake to wake-sleep transitions, which in turn reduce the chance of going back to SWS and favor LWS before the final sleep-wake transition, resulting in less sleep inertia and therefore better mood. These results could therefore align with Mattingly et al's (2022) observation of elevated heart rate before awakening in participants who snoozed compared to those who did not snooze.

This is the first study to examine the snoozing phenomena and its effect on mood, therefore, more studies are required before any conclusions can be made. If future research does confirm these findings, medical professions and sleep scientists might start recommending snoozing to improve mood in well-rested individuals. But it must be emphasized that this study only includes well-rested participants, and that research on snoozing's effect on participants with mood disorders must be done before any new recommendations can be made in forms of treatment.

However, because of the small sample size, small effect size, and the low factor loadings together with high uniqueness in items, it is unlikely that these results has any real implications. One possible explanation to the NA scores non-significant result, could be because of the NA adjective's low psychometric properties. This could maybe have been prevented by using another instrument, or by using the short version of PANAS (I-PANAS-SF), that only use 10 adjectives, 5 for PA and 5 for NA (Thompson, 2007).

There are more things to consider when discussing the thesis methodology. Internal validity refers to the degree of confidence that the causal relationship is not influenced by other variables or factors (Borg & Westerlund, 2012). Starting off with discussing demand characteristics.

Demand characteristics is described as the phenomenon when participants respond in a way that either confirms or disconfirms the hypothesis of the experiment (Harmon-Jones et al., 2007). This happens when participants get clues that might indicate the research objective, in other words, when participants can guess the hypotheses that are being studied. This is a phenomenon that is important to discuss because experimental studies want participants to react as if they normally would, without being influenced by factors such as self-presentational biases or concerning themselves with what is socially desirable or not. One way to try and avoid this is to use methods that makes it harder for participants to find out the actual hypothesis. This study was trying to avoid this phenomenon by telling participants that the study only intended to measure how they felt when waking up. The survey included questions such as gender, age, when they go to sleep and wake up, as well as to where they live to try and take focus away from snoozing and mood. But even with these questions, this study could arguably be influenced by characteristic demands because the studies purpose was described in the information page, however, without explicitly mentioning mood or snoozing.

Because the sample was recruited mainly from personal connections, there were a lot of people who knew about the studies true purpose due to me being so passionate about it. This might have led to some participants trying to be helpful and overestimate their mood ratings, or that some were trying to act the way as if they would as if they didn't know. Because of the high risk of demand characteristics, the results way not accurately reflect the results of some participants actual mood, thus resulting in low internal validity which in turn compromises the external validity.

By using a non-experimental research design, it means that we only can observe a possible relationship between the independent and dependent variable, when there could be other factors that might influence the results, thus also limit the internal validity. Therefore, we need to discuss possible spurious correlations.

What day you conduct the experiment could affect mood. Studies such as Thorleifsdottir et al. (2002) has observed that weekly sleep patterns appear to be rather consistent across early life (because of daily weekly activities such as work, school etc), but the sleep patterns change in the weekends and gets displaced towards later hours of bedtime and wakeup time. This difference in sleep patterns might have an impact on mood when waking up due to factors such as family structure, employment and hobbies. Harmon-Jones et al. (2007) also highlights the impact of the "Blue Monday" phenomenon, which refers to Mondays generally being perceived as the worst day of the week and therefore participants may recall their mood worse on Mondays compared to other days. Staying in bed after awakening might also have an effect on mood and sleep inertia. However, no such studies were found on healthy participants. The only studies that were found on the subject of people having difficulties getting out of bed, was observed in participants with depression and that it might be caused by them having increased sleep inertia compared to healthy participants (Cassano et al., 2009 & Ritter et al., 2012).

Differences in sleep behaviours could also affect mood. Factors such as winter depression might influence people to spend more time in bed compared to in the summer. Sleep behaviours could also be influenced by where you are in the world. As an example, adolescents in Iceland have been observed to go to bed later and to wake up earlier, resulting in them having less sleep compared to other countries (Thorleifsdottir et al., 2002).

Gender differences could cause differences in the results. Women's menstrual cycle might lead to exaggerated ratings of mood whilst men might underestimate their ratings due to them wanting to uphold a stereotypical behaviour that men aren't supposed to have strong feelings.

The environment when waking up might also cause mood changes. Some might sleep alone and therefore feel alone, resulting in worse mood. Others might live with a partner, child or a pet that generates a positive mood after having woken up. However, the second test is more subjective to environmental factors compared to the first test. A lot can happen within the span of one hour. Some participants might have to go to a workplace which they dread, which causes negative mood, whilst others might start their day with a house filled with birthday decorations, which includes balloons and a bounce castles, which might generate a positive mood.

We also need to consider the snoozing conditions. First of all, people might not only use one of these two options (snooze or no-snooze) when waking up. Some might use both of these methods. A partner's alarm or some other external noise could yield the same results as a snooze-condition without even being considered as a snoozing. There might even be participants that missed their alarm entirely and woke up later than intended, thus, evoking stressful feelings of being late to their daily occupation. Other might naturally wake up right before their alarms, not knowing that there is no such condition, but still completes the tests.

We also need to discuss possible limitations regarding the methods used to collect data. Starting off with face validity. Face validity refers participants evaluation of the person in charge of the study and if that person is believed to know what they are doing (Borg & Westerlund, 2012). This is hard to assess, but because of my passion for the subject has been projected to some of the participants, and because the information page does indicate at least some degree of knowledge within the area, this might have led to good face validity.

The process of manually transferring data from 3 separate Google Forms over to three different Excel documents must also be discussed. Such manual handling could cause errors due to tiredness which might lead to putting in the wrong numbers for the wrong participants. However, in a try to minimize this risk, the data was checked twice after the manual transfers to ensure no such errors was made.

Another interesting thing is the gender distribution in the study sample. The sample consisted of a large majority of men, which is rarely seen in these types of tests. Usually, it is females that dominates the samples within psychological studies. The reason behind this unusual distribution can only be speculated. Maybe it is more common for men to wake up with a bad mood compared to women, thus, resulting in more male participants wanting to participate in the study, wishing it might lead to new knowledge and recommendations. Maybe it was because the sample consisted of personal connections where males were the once who was more willing to help by participating compared to females.

Future research

Hopefully, this thesis could work as a starting point for future research that further examines this snoozing-phenomena. Future research is recommended to examine the same research question, but with the use of a real experiment that has full control of the variables and with the use of a polysomnography to monitor sleep stages.

Future research must also be done to further confirm the assumption that LWS actually do reduce the effects of sleep inertia and the relationship between SWS and sleep inertia, as well as confirming the assumption that reduced sleep inertia improves mood. Such confirmation might lead to the development of new wake up methods and devices that identifies snoozing patterns to avoid individuals going into deep sleep between snoozing-intervals and through activating multiple alarm whilst still in LWS. However, similar devices have already existed for quite a while.

Sleep tracking devices has existed for many years and were developed with an aim to wake individuals whilst in LWS. This technology is based on the same belief as mentioned before, that LWS reduce sleep inertia. There are multiple types of "sleep tracking devices" such as an actigraphy (a wristband that measures movement), ÖURA (ring that tracks heart rate) and many different types of applications. However, no device other than a polysomnography have been proven to accurately monitor sleep cycles (de Zambotti et al., 2019; Asgari Mehrabadi et al., 2020; Roberts et al., 2020). These "sleep tracking devices" have showed next to no correlation with a polysomnography. If future research could confirm the assumption that LWS reduce sleep inertia, there could be an increased demand in the development of new and more accurate devices that tracks sleep stages.

There are other types of alarms that have tried to reduce the effects of sleep inertia. However, research on these types of alarms are non-existent. New alarms have been developed to mimic a sunrise, where the reason could be to reduce the production of melatonin in the body in order to reduce sleep inertia. Even though there are no research that have monitored the melatonin secretion when participants wake up, but there are those who suggest that melatonin helps induce sleep and other sleep-maintaining effects (Brown, 1994). In other words, melatonin seems to have nothing to do with the sleep-awake transition. Melatonin is often used to treat patients with sleep problems but there are no mentions that could strengthen the argument that a light-based alarm could reduce sleep inertia.

Other alarms have been designed to be hard to stop, or alarms that are instructed to be placed away from the bed. But these have no empirical evidence behind them. It could be that physical activation also activates the SNS, which in turn mimics the same physiological changes that occurs during CAR. Kovac et al. (2021) studied the impact of a short burst of exercise on sleep inertia in participants after they woke up. They suggested that a short burst of exercise does reduce sleep inertia. Their results also suggest improved subjective sleepiness after a 30 second walking exercise in participants right after having woken up. But they too highlight the need for more research on the subject before any conclusions can be made.

In summary, there have since a while back been developed technology to monitor sleep stages and to reduce sleep inertia by using light or physical activation. However, this technology has lacking or no empirical evidence behind it. Therefore, new empirical research is needed to examine different sleep-wake transitions to better be able to develop new technology that could lead to improved physiological health in the general population.

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