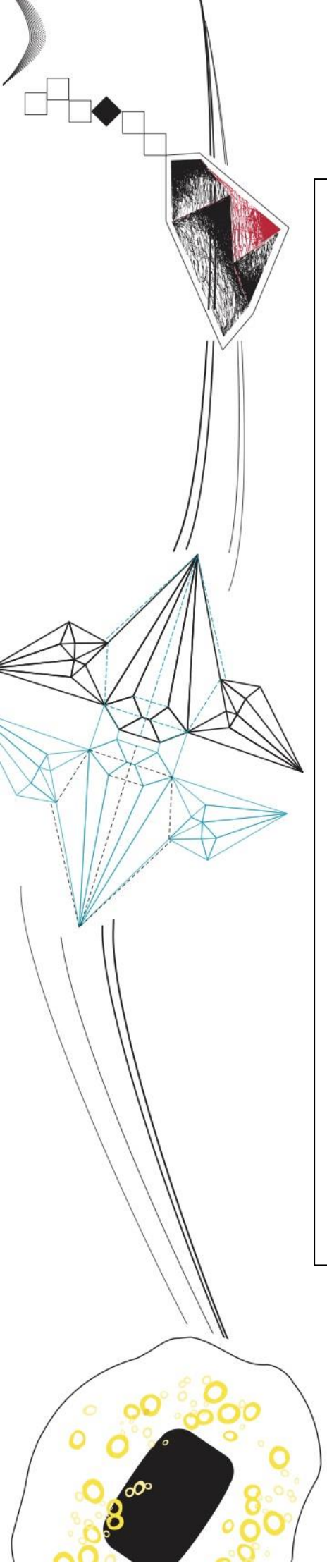


The effectiveness of and experience with an innovative split-sleep schedule in healthy nurses

A mixed method study

Marleen van der Stouwe - S1666665

April 2017

Master thesis health psychology

Supervisors:
Dr. E. Taal (University of Twente)
Dr. C. H. C. Drossaert (University of Twente)
Dr. A. van der Lans (Philips Research)

PHILIPS UNIVERSITY OF TWENTE.

Acknowledgement

The current thesis is the final mandate of the master in Health Psychology at University of Twente. This project started almost a year ago with an internship and turned into a master thesis project at Philips Research in Eindhoven. After this year with a lot of ups and downs, some long train travels to Eindhoven, early mornings, incredible sprints at train stations, I proudly present this thesis. I have learned a great deal about conducting and reporting scientific research. There are a couple of people I wish to thank.

First of all I would like to thank Dr. Erik Taal for his support and critical feedback on the project and my thesis as being my first supervisor. Next, I would like to thank Dr. Anouk van der Lans for her optimism, support, and critical remarks as supervisor at Philips Research. In addition, I wish to thank Dr. Stans Drossaert for her valuable feedback and critics on my thesis which really have helped to take my writing to a higher level.

Furthermore, I want to thank the project team at Philips Research, colleagues and students who supported me. Finally I would like to thank my family and friends for their interest and support.

Thank you all.

Abstract

Background

Shift work is currently becoming increasingly more common, however it has two major hazards: It increases the risk of occupational accidents and injuries, as well as the development of (chronic) disease. One of the contributing risk factors is sleep deprivation. It is known that a split-sleep schedule can be an effective countermeasure for shift workers with sleep deprivation. However, existing split-sleep schedules are not effective on successive night shifts or require significant work-environmental changes. This study therefore focussed on testing an innovative split-sleep schedule and exploring participants' experiences with it by adopting the Theory of Planned Behaviour (TPB).

Methods

The sample consisted of 18 nurses who were randomly assigned to a split-sleep group (who were given sleep advice and slept 5/6 hours during the day and 2/3 hours during the evening) or to a consolidated group (who slept as they usually do). The following outcomes were observed: objective sleep (measured with the Actiwatch), alertness (measured with the psychomotor vigilance task) and subjective sleepiness (measured with the Karolinska sleepiness scale). After the study, participants were interviewed based on TPB in order to explore their attitudes, subjective norm, perceived behavioural control, and intentions for continuation.

Results

Preliminary results show two trends. Firstly, the total sleeping time (TST) during two nights after the night-shift series was higher (p = 0.09) for the split-sleep group, indicating that this group slept more hours during the two nights after the night-shift series compared to the consolidated group. Secondly, the split-sleep group had fewer lapses during the night shift (p = 0.09), indicating higher alertness during the night shift compared to the consolidated group. Participants in the split-sleep group were generally positive and found it easy to follow the split-sleep schedule. Frequently named advantages were enjoying more of the day, finding it easier to plan meals and to eat and experiencing positive effects during the night shift. Important disadvantages that participants named were the influence on their social life, having to change daily schedule and being preoccupied with sleep. Participants found it easier to follow and were more probable to continue with the split-sleep schedule when it was personalized to the individual shift worker. Participants in the consolidated group were generally more negative, as they perceived some difficulty in following the schedule. In general, the consolidated group perceived the same advantages and disadvantages, however did not mention a perceived positive effect during the night shift. Two participants dropped out, as they were unable to sleep during the evening-sleep opportunity in the night-shift series.

Conclusions

The innovative split-sleep schedule appears to be promising for the majority of shift workers who are able to sleep during the evening. The split-sleep schedule is beneficial shortly after a night-shift series as well. Important implementation strategies are personalizing the split-sleep schedule and informing society about split-sleep and its advantages. However, current results are preliminary and further research is therefore needed.

Keywords: split-sleep schedule, effectiveness study, shift work, Theory of Planned Behaviour.

Index

1. Introduction

Shift work is currently becoming increasingly more prevalent. Sleep deprivation is common among shift workers and can lead to occupational accidents and/or health problems. Therefore, the current study focussed on the effects of adopting an innovative sleep schedule in order to decrease sleep deprivation. This may prevent occupational accidents and injuries, and in the long term diminish the development of (chronic) diseases.

Though the term 'shift work' appears to be straightforward, it can have different meanings. While most articles do not define it, Åkerstedt (1998) distinguishes four types of shift work: day work, permanent shift work, rotating shift work and roster shift work. This distinction is the result of differences in working hours and the flexibility of the work schedule, rather than only the days of the week. Roster shift work is mostly used in health care and forms the basis of the definition of shift work for this report. Shift work was defined as: working on a roster schedule that is flexibly implemented, has no clear sequence and in which all days of the week were considered as workdays. Thus, shift workers can be scheduled to work on mornings, evenings, nights, weekdays and weekend days.

Most employees in the Netherlands work outside of office hours (8 a.m. to 6 p.m.). According to Centraal Bureau voor de Statistiek (CBS; CBS, 2014), only 15% of the working population in the Netherlands works entirely during the daytime on weekdays, which entails that 85% of the working population works irregularly. This is a slight increase of 4.3% compared to 2000 (CBS, 2014). Of the 85% of irregular workers, 25.2% works entirely irregularly and thus fits the definition of a shift worker that is adopted here.

Although shift work is increasingly more common, it is associated with certain hazards. The first is the well-known association of shift work with occupational accidents and injuries. Folkard and Tucker (2003) argue that, compared to working a morning shift, working a night shift increases the risk of accidents and injuries at work by 30.4%. De Castro et al. (2010) found in a large sample of Philippine nurses a 54% increased risk of being injured at work and a 48% increased risk of involvement in occupational accidents. In addition, Dembe, Erickson, Delbos, and Banks (2006) found in previously gained data a hazard ratio of 1.15 for irregular shifts. Thus, working on an irregular roster increases the risk of occupational accidents by 15%, although few data are available.

In addition to work-related risks, the second hazard is the association of shift work with the increased risk of unwanted health outcomes. For example, Wang et al. (2013) found a 19% increased risk of developing breast cancer for people who work night shifts, with a risk increase of 3% for every five years of exposure to shift work. In addition, Vetter et al. (2016) found a 12% increased risk of developing coronary heart disease, with an increase of 19% after five years and a 27% increased risk

of developing coronary heart disease after ten years. Furthermore, shift work increases the risk of diabetes type 2 by 3% (Pan, Schernhammer, Sun, & Hu, 2011), with risk increases of 6% after three years of exposure to shift work, 10% after ten years of exposure and up to 24% after twenty years of exposure. Finally, peptic ulcer disease was rated to be 2.18 times more frequent in shift workers compared to day workers. Thus, shift work is not without risks and the more shifts and/or the more time spent working in shifts, the higher the risk to develop (chronic) diseases (Segawa, Nakazawa, & Tsukamoto, in: Khanijow, Praksash, Emsellem, Borum, & Doman, 2015).

1.1 Risk factors for occupational accidents and injuries, and diseases

Different risk factors contribute to occupational accidents and injuries, and the development of (chronic) diseases. Though the precise relations are not clear, it is recognized that the following three risk factors play a role: sleep deprivation, lifestyle changes and disrupted social life (Bøggild & Knutsson, 1999; Kecklund & Axelsson, 2016; Härmä, 2006). Each of these are explained in what follows.

Firstly, shift work is associated with a disrupted sleep-wake cycle (Kecklund & Axelsson, 2016). The underlying mechanism is the circadian rhythm: the natural rhythm of the body that fosters wakefulness and sleepiness (Bass, 2012). The circadian rhythm can be considered as an internal biological clock that promotes wakefulness during the biological day and reinforces sleep during the biological night (Gonnissen et al., 2013). The master of the circadian clock**,** called the suprachiasmatic nucleus (SCN), is located close to the hypothalamus and consists of thousands of light-sensitive neurons (Morris, Aeschback, & Scheer, 2012), which is why the system is tightly synchronized with the environment's light and darkness. In addition, it has the ability to slowly adjust to external cues such as light (Cipolla-Neto, Amaral, Afeche, Tan, & Reiter, 2014; Morris et al., 2012). The SCN communicates through hormones, the endocrine (a collection of glands that, among other things, regulates growth and the metabolic system) and neural signals, resulting in bodily processes that are coherent with time for optimal performance (Haus & Smolensky, 2013). Therefore, mammals are active during the day and asleep during the night. However, as shift workers' work and sleep times rotate within the 24-hour cycle, their light exposure changes. Since shift workers may work and sleep at times at which the circadian rhythm normally promotes activity, an association exists between shift work and the disruption of the normal sleep-wake cycle.

As shift work disrupts the sleep-wake cycle, it is associated with sleep deprivation. It is recommended to sleep between six and eight hours a night, because most people naturally sleep that many hours, without setting an alarm (Vitra et al., 2013; Gleitman, Gross, & Reisber, 2011). However, shift workers who work night shifts sleep during the day, when the biological clock promotes

wakefulness. Due to the distortion of their natural rhythm, shift workers sleep only four to six hours during the day after a night shift (Chatzitheochiari & Arber, 2009; Ohayon, Smolensky, & Roth, 2010; Åkerstedt & Wright, 2009). Consequently, they miss two to four hours of sleep each day following a night shift and become sleep deprived.

Sleep deprivation may be a mediator between shift work and the increased risk of occupational accidents and injuries, and unwanted health outcomes (Kecklund & Axelsson, 2016). Firstly, sleep deprivation is associated with sleepiness, reduced alertness and performance during a night shift, which may lead to occupational accidents and injuries during the night shift (Åkerstedt, 1995; Åkerstedt, 1998; Belenky, Wu, & Jackson, 2011; Rajaratnam & Arendt, 2001; Wagstaff & Sigstad Lie, 2011). For example, Härmä et al. (2002) found in a large group of locomotive engineers that the odds of feeling severely sleepy was six to fourteen times higher during night shifts compared to day shifts. In addition, 49% reported severe sleepiness during the night shift.

Secondly, due to sleep deprivation, numerous endocrine rhythms become altered, which can negatively influence health (Costa, Haus, & Stevens, 2010). For example, the neuro-endocrine system control's cell growth and changes in the system's feedback loop may result in abnormal cell growth (Haus & Smolensky, 2013). This is an important cause of tumour growth. In addition, long-term exposure to sleep deprivation is associated with DNA changes, which make people even more sensitive to diseases such as cancers and can be passed on to future generations (Haus & Smolensky, 2013). Moreover, sleep deprivation has a negative influence on the immune system, as this system is closely integrated within the endocrine system's feedback loops. After sleep deprivation, the activity of T-helper cells is decreased. T-helper cells are important for the production of T-killer cells, which fight diseases (Haus & Smolensky, 2013). Finally, there is evidence that sleep deprivation negatively influences glucose tolerance and insulin reaction: Spiegel, Leproult and Van Cauter (1999) found that sleep deprivation decreases tolerance to glucose and the acute reaction of insulin to glucose, which can result in high blood sugar and eventually diabetes type 2 (Spiegel, Leproult, & Van Cauter, 1999; Knutson & Van Cauter, 2008). Therefore, shift workers are more vulnerable to viruses, infections, diabetes type 2, and cancer.

The second risk factor is the association of shift work with unhealthy lifestyle changes regarding eating, smoking, alcohol and exercise. Firstly, shift work is associated with increased body weight and obesity (Proper et al., 2016; Knutson & Van Cauter, 2008). While being obese is already a risk factor for diabetes type 2 (Schmidt et al., 2013), Pan et al. (2011) also found that Body Mass Index (BMI) partly mediates the relation between shift work and diabetes type 2. However, it is unlikely that this association is caused by the amount of food intake, as Bonham, Bonnell, and Huggins (2016) found no difference in energy intake between shift and day workers. The authors suggest that explanations

should be examined with regard to meal timing, food choice and variation of energy metabolism at night. Cain, Filtness, Philips, and Anderson (2015) found in a simulated night-shift experiment that night workers had a significantly higher preference for high-fat foods for breakfast, compared to a control group. This preference may lead to weight gain and eventually to obesity. Furthermore, Khanijow et al. (2015) argue that the irregular timing of meals (which is common among shift workers) may result in peptic ulcer disease. Secondly, shift work is associated with increased smoking, higher alcohol intake and less exercise compared to day work (Nea, Kearney, Livingstone, Pourshahidi, & Corish, 2015; Bøggild & Knutsson, 1999). This may make shift workers less healthy compared to day workers, although the evidence is not entirely convincing.

The third and final risk factor for disease development is disrupted social life. Shift work and especially night-shift work is associated with a disrupted social life. White and Keith (1990) found that shift work has a modest negative effect on marriage quality and it is also associated with an increased probability of divorce from 7% to 11% within three years. While working in shifts, the amount of time spent with spouse and family may be unsatisfying, as the shift worker is either sleeping or very tired from the lack of sleep or from poor sleep (Finn, 1981). In addition, shift workers are not always able to attend all social and family-related activities, which may result in stress and social isolation (Frost, Kolstad, & Bonde, 2009). Stress and social isolation may influence a person's health negatively and Pisarski, Bohle, and Callan (1998) found that social support has a direct influence on self-reported psychological and physical wellbeing. Therefore, having low social support may lead to poorer self-reported health. However, (recent) literature on this topic is scarce, possibly because the increase of shift work makes social disruptions less problematic.

All in all, the abovementioned aspects negatively influence work activities and increase shift workers' risk of developing (chronic) diseases. Although it is clear that shift work has major negative side effects, it is inescapable for some occupations (e.g., nurses, pilots, doctors or bakers). In high-responsibility jobs, accidents are extremely unwanted, as people's lives are on the line, thereby finding a solution is needed.

1.2 Split-sleep

A possible solution by which to counteract the first risk factor for shift-work hazards, sleep deprivation, is to implement a split-sleep schedule. A split-sleep schedule is associated with more minutes of sleep, less sleepiness and higher alertness during a night shift compared to consolidated day sleep (sleeping one time during the day; Jackson, Banks, & Belenky, 2014; Tremaine et al., 2010). The current study defined split-sleep as two or more sleep opportunities within a 24-hour period (Belenky. Hursh, & Fitzpatrick in Belenky, Wu, & Jackson, 2011).

1.2.1 Different kinds of split-sleep schedules

There are many options for split-sleep. The first is through napping strategies. Taking naps during the night shift is a well-known countermeasure against sleep deprivation, because napping during the night shift may prevent a decline in alertness and improve performance during the night shift (Tremaine et al., 2010; Ruggiero & Redeker, 2014). McDonald et al. (2013) studied medical residents in a real-life setting, who worked on a rotating schedule (either a day or night shift, with rotations lasting for four weeks). During the study, participants who worked the night shift split their sleep into one main diurnal sleep period and a nocturnal nap on a chosen time. The authors found that night-shift workers who split their sleep had an equivalent total sleeping time (TST), reaction time and learning ability compared to those of day workers who slept during the night. The authors conclude that the total time spent in bed within 24 hours was the determining factor for these results. In addition, Ruggiero and Redeker (2014) suggest that shift workers who nap during the night shift may nevertheless be sleep deprived. In the authors' literature review, the participants in most studies that were included slept shortly during daytime (between four and six hours). Therefore, napping during the night shift appears to only be an effective countermeasure for occupational accidents and injuries, and not for unwanted health outcomes. Consequently, Ruggiero and Redeker (2014) propose that nap interventions should focus on improving the TST within 24 hours and that napping during the night shift should not be used as a replacement for gaining sufficient sleep during the day after a night shift.

In addition to its ineffectiveness against sleep deprivation, napping during the night shift has two other disadvantages. Firstly, the risk of sleep inertia, which refers to a period of disorientation, decreased performance or sleepiness that can be experienced immediately after awakening (Tassi & Muzet, 2000). Sleep inertia is likely to arise when the nap is longer than 30 minutes or when it takes place at the bottom of the circadian phase (e.g., during the night or after long waking hours; Ficca et al., 2010; Hilditch, Centofanti, Dorrian, & Banks, 2016). A longer sleep duration and/or more depth of sleep lead to more severe sleep inertia (Brooks & Lack, 2006; Muzet, Nicolas, Tassi, Dewasmes, & Bonneau, 1995; Tremaine et al., 2010). Sleep inertia can last as long as two hours (Takahashi, Arito, & Fukuda, 1999), thereby indicating that a shift worker needs to take at least four naps to increase the TST with two hours, which they are likely to miss. No data about the effectiveness of multiple short naps during night shifts are available and further exploration is needed (Ficca, et al. 2010). The second disadvantage is the fact that sleeping during night shifts implies drastic work-environmental changes (Bonnefond, Tassi, Roge, & Muzet, 2004; Fallis, McMillan, & Edwards, 2011). For example, in hospital settings, extended breaks (for napping) require more staff deployment (Edwards, McMillan, & Fallis,

2013), which may result in higher health-care costs. Therefore, sleeping during the night shift may not be the best generally applicable solution by which to tackle sleep deprivation.

The second and less recently studied nap strategy is sleeping before sleep deprivation occurs (e.g., before a night shift). These so-called prophylactic naps should reduce the homeostatic sleep pressure (the desire to sleep) during the night shift. The sleep pressure is a result of prior time spent awake (Takahashi, 2003; Garbarino et al., 2004), which may positively influence performance and alertness during the night shift. The classic study of Bonnet (1991) found that participants who slept before a period of sleep deprivation were more alert and performed better during their first night of sleep deprivation compared to those in a no-nap condition. Even though these naps are less sensitive to sleep inertia, no positive results were found in the second night of sleep loss (Hofer-Tinguely, et al., 2005; Bonnet, 1991). Therefore, prophylactic naps may not be effective for successive night shifts.

The second split-sleep strategy is to divide sleep opportunities more equally. Mollicone, Van Dongen, Rogers, and Dinges (2008) found that splitting sleep into 50% to 80% of the TST during the night and a nap (of 20% to 50%) during the day had no adverse effect on attention and subjective sleepiness during the day. In addition, Roach et al. (2015) conducted a laboratory study comparing consolidated sleep with an equally divided split-sleep schedule. Both groups followed forced desynchronised sleep schedules within 28 hours and therefore slept during every sleep opportunity at different circadian times. No differences were found regarding TST and the authors suggest that split-sleep has no adverse effects. In addition, Jackson et al. (2014) conducted a laboratory study with healthy volunteers who were divided into three different groups: night-time sleep, daytime sleep and split-sleep. Participants in the split-sleep group split their sleep into equal sleep opportunities (50% from 3 a.m. to 8 a.m. and 50% from 3 p.m. to 8 p.m.). Though the split-sleep group slept significantly more hours and had lower subjective sleepiness compared to the day-sleep group, no differences were found in alertness. It therefore appears to be interesting to try to increase shift workers' total time spent in bed by following a split-sleep schedule. However, one disadvantage is that the equally divided split-sleep schedule requires, as with napping during the night shift, significant work-environment changes (Fallis et al., 2011), which make the implementation of a certain schedule less probable in a real-life setting.

In summary, the discussion above indicates that split-sleep may be a promising strategy by which to counteract sleep deprivation among shift workers. However, there is limited data available regarding the effectiveness of specific split-sleep schedules in real-life settings (e.g., Jackson et al., 2014; Kosmadopoulos et al., 2014; Ficca et al., 2010). In order to avoid the disadvantages (sleep inertia, only first-night effects and not having to change working environments) of previously developed and studied split-sleep schedules, a new split-sleep schedule was created for this study.

1.3 The innovative split-sleep schedule

The innovative split-sleep schedule is based on the prediction models of Åkerstedt and Folkard (1995; 1996a; 1996b). The authors created three models by which to predict sleep duration, sleep-onset latency (SOL; the time between bed time and the beginning of sleep) and alertness at different times within the 24-hour cycle (*Figures 1, 2* and *3*). Each model consists of curves, which represent the circadian variation over the time of day within 24 hours. The numbers on the right vertical axis represent prior time awake, while the left vertical axis represents the prediction value of sleep duration, SOL or alertness. Circadian influence, homeostatic influence, prior time awake and long work hours were contributing factors to sleep duration, SOL and alertness.

Firstly, the prediction model for sleep duration predicts that the higher the prior time awake, the longer the sleep duration. Therefore, after a night shift when prior time awake is long, shift work may not appear to have an adverse impact on sleep duration during daytime. However, sleeping during the day takes place at the circadian peak, when the circadian rhythm promotes activity. The model therefore predicts that day sleep results in lower sleep duration compared to night sleep and that the sleep duration when going to bed in the morning (e.g., around 8 a.m.) is of around five hours (until 1 p.m. / 2 p.m.). In addition, according to the model, it is possible to nap during the early evening, as prior time awake is at maximal six hours.

Secondly, the prediction model for SOL predicts that the longer the time awake, the shorter the SOL. For example, the model predicts that the SOL is around five minutes in the morning after 12 hours of being awake, which is low. When napping during the early evening, the predicted SOL is between 20 and 25 minutes. Therefore, the nap should be between two and three hours.

The last model, regarding alertness, predicts that alertness is the lowest at the circadian nadir, between 3 a.m. and 6 a.m. at night. Though the nadir of the circadian rhythm cannot be prevented, its influence on alertness is adjustable and the model predicts that a shorter prior time awake results in a higher alertness during circadian nadir. Therefore, the nap during the evening appears to be an interesting countermeasure for decreased alertness.

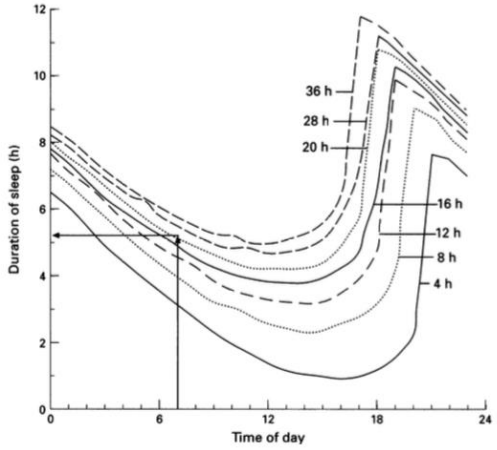


Figure 1. Predictive model of sleep duration (Åkerstedt & Folkard, 1996b). Each curve represents the predicted total sleep time, after a given number of prior hours awake. By drawing a vertical line at a certain time of day towards the appropriate curve and a horizontal line towards the left, the predicted duration of sleep can be observed.

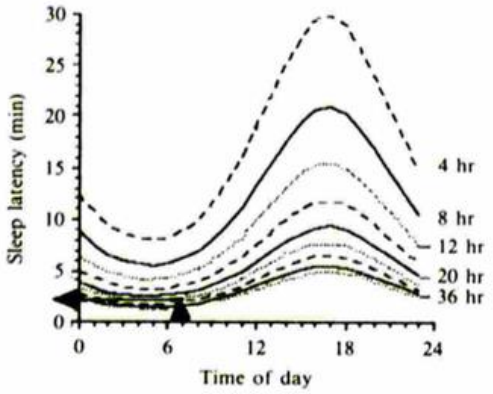


Figure 2. Predictive model of sleep latency (Åkerstedt & Folkard, 1996a). Each curve represents the circadian variation of sleep latency at a certain time of day, after a certain number of awake hours (right side). The sleep latency is calculated by drawing a vertical line towards the appropriate curve and drawing a horizontal line towards the left.

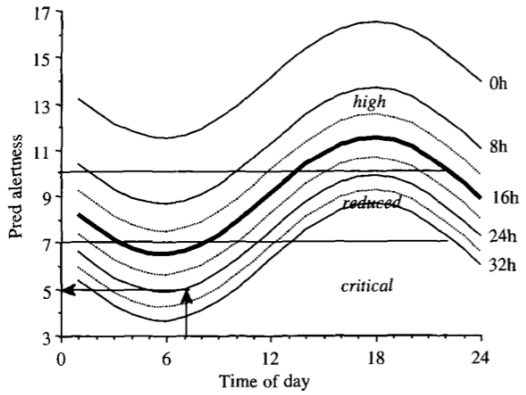


Figure 3. Predictive model of alertness (Åkerstedt, 1995). Each curve represents the circadian variation of alertness at a certain time of day and after a certain number of awake hours (see right side). The predicted alertness score is found by firstly drawing a vertical line form the time of day towards the curve that fits the prior time awake and secondly drawing a horizontal line from the curve towards the left vertical axis.

1.4 Experiences with the split-sleep schedule

In addition to the effectiveness of a split-sleep schedule, it is necessary to understand participants' experiences with it. These data are essential in creating a split-sleep schedule that fits shift workers and their environment, which makes the target group's implementation of the schedule more probable.

There is insufficient data available about these experiences. However, according to Bonnefond et al. (2001), the satisfaction with a nocturnal nap during the night shift increased over time. After six months, two thirds of the participants believed that they were "very well adapted" to the naps during the night shifts, which indicates that finding comfort with a split-sleep schedule does not occur immediately. The remainder of the studies regarding split-sleep are focused on effectiveness and eliminated the subjects' experiences.

The current study therefore examines participants' experiences with the split-sleep schedule by adopting the explanatory model of the Theory of Planned Behaviour (TPB; Ajzen, 1991): a model that has proved to be successful in behavioural-change programs for a variety of health problems, such as diet, exercise and, to lesser extent, sleep (Gratton, Povey, & Clark-Carter, 2007; Darker, 2007; Knowlden, Sharma, Bernard, 2012). The TPB can also be used to explore motivations and barriers for specific health-related behaviours, such as sleep behaviour (Brennan et al., 2016; Lao, Tao, & Wu, 2016). The theory is mostly applied on an individual level, as in the current study, and proposes that behaviour is directly influenced by one's intention to perform that behaviour and indirectly influenced by three constructs: attitudes, social norm and perceived control (see *Figure 5*). Attitudes refer to a person's thoughts and feelings towards certain behaviour. The subjective norm refers to people's thoughts, feelings and opinions on what their environment thinks and feels towards a particular behaviour. Finally, the perceived behavioural control is a person's individual evaluation of his/her self-efficacy. The power of TPB is that the three core constructs are changeable. By exploring these constructs, clear recommendations for the implementation of the split-sleep schedule in a real-life setting can be found.

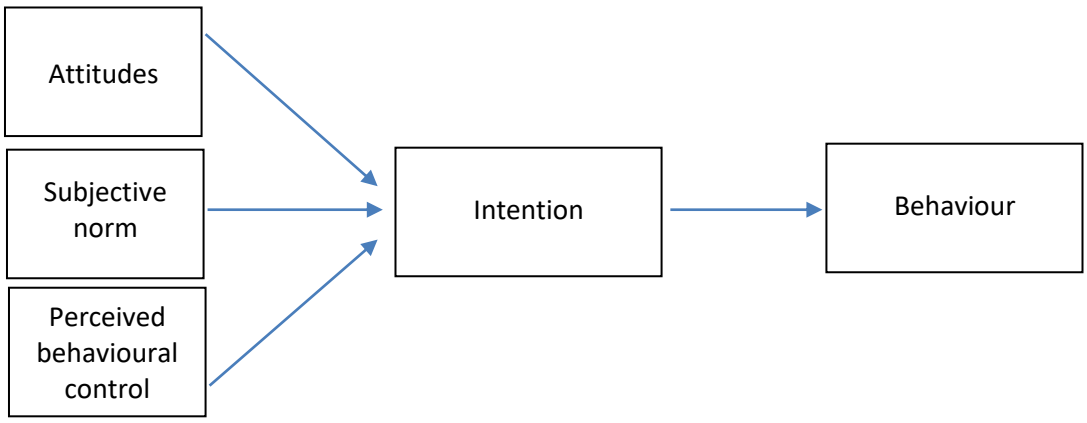


Figure 5. Theory of Planned Behaviour (Ajzen, 1991).

1.5 Summary

In summary, shift work has two major hazards (increased accidental risk and unwanted health outcomes) and three associated risk factors: sleep deprivation, lifestyle changes and a disturbed social life. Though a split-sleep schedule appears to be an effective countermeasure against sleep deprivation, existing split-sleep schedules have the major disadvantage that they require significant work-environmental changes. This forms the motivation for creating an innovative split-sleep schedule in the current study, which focuses on the effectiveness of the split-sleep schedule and on participants' experiences with it in a real-life setting, in order to create implementation recommendations. This leads to the following research questions:

1. *What is the effectiveness of a split-sleep schedule on objective sleep, alertness, and subjective sleepiness of nurses who work night shifts in a real- life setting?*
2. *What are the effects of the split-sleep schedule on two nights after the night-shift series on objective sleep of nurses who work night shifts in a real-life setting?*[1]

Hypotheses

1. The split-sleep schedule leads to higher TST during the night-shift series compared to a continuous sleep schedule.
2. The split-sleep schedule leads to higher alertness during night shifts compared to the continuous sleep schedule.
3. The split-sleep schedule leads to a lower self-reported sleepiness during night shifts compared to the continuous sleep schedule.

3. *What are participants' experiences, attitudes, subjective norm, perceived behavioural control and intentions towards the split-sleep schedule?*
4. *What are the recommendations for implementing a split-sleep schedule for nurses who work night shifts in a real-life setting?*

[1] No hypothesis was formulated, as no research data is available.

2. Method

The study was initiated by Philips Research and took place at, and in collaboration with, the Catharina Hospital Eindhoven. On 5/23/2016 the internal commission of biomedical experiments of Philips approved the study.

2.1 Sample

The sample consisted of 18 nurses and was recruited at the Catharina Hospital in Eindhoven[2]. All participants were required to work during four to eight weeks in two series of at least three night shifts in order to be included. The night shifts started around 11 p.m. and lasted until around 7.30 a.m. Nurses with ten or more years of experience were excluded from participation due to the possibility that they already developed coping strategies, which could negatively influence their compliance with the split-sleep schedule. In order to ensure that participants with major sleep problems were excluded, the Pittsburgh Sleep Quality Index (PSQI) of Buysse et al. (1988) was completed. This questionnaire distinguishes good and poor sleepers with an easily and quickly calculated score. The cut-off sore was eight or higher (Han, Yuan, Zhang, & Fu, 2016). None of the participants needed to be excluded, as none of them scored ≥8 on the PSQI questionnaire. Other exclusion criteria were the use of sleep medication, taking holidays for more than five days or traveling to another time zone.

The nurses were sampled through convenience sampling. They were sent an information letter and they could sign up via e-mail or telephone. In addition, anonymous rosters were sent to the research team and when nurses fitted the inclusion criteria, their e-mail addresses were requested and they were approached actively by e-mail, providing them with short and detailed information.

The nurses were divided randomly into two groups, the split-sleep condition (n = 9) and the consolidated condition (n = 9). This division was created by drawing lots between two participants in order to ensure that both had the same chances of being in one of the groups. Drawing lots was the easiest way of doing so, as participants signed up gradually. Participants in the split-sleep group received the advice to split their sleep (see paragraph *2.1.1* for an explanation) and the consolidated group slept once per day, as usual.

2.1.1 Split-sleep schedule

The split-sleep group received the advice to split their sleep (see Table 1). The first sleep opportunity was approximately 70% of the TST (within 24 hours), and was obtained during daytime. The second sleep opportunity was 30% of the TST and was obtained during the (early) evening: the equivalent of five to six hours after a night shift and two to three hours before the next night shift. Participants were

[2] Though the plan was to include 40 nurses, only 18 of them are analyzed in the current thesis due to time limitations.

advised to sleep the night before their first night shift for a maximum of 70% (six hours) of the TST in order to increase the desire to sleep, the so-called sleep pressure, before the first night shift. In other words, by limiting the sleep on the preceding night, participants felt sufficiently sleepy to sleep before their first night shift. The evening nap before the first night shift served as a shift-over to the split-sleep schedule. Outside of the night-shift series, participants could sleep as usual.

Table 1

The split-sleep schedule for one series of three night shifts

Moment	Hours
Night before night shift	Maximal 6 hours
Pre first night shift	2/3 hours (18.00/19.00 until 21.00)
Post night shift	5/6 hours (8.30 until 13.30/14.30)
Pre night shift	2/3 hours (18.00/19.00 until 21.00)
Post night shift	5/6 hours (8.30 until 13.30/14.30)
Pre night shift	2/3 hours (18.00/19.00 until 21.00)
Post night shift	5/6 hours (8.30 until 13.30/14.30)

2.2 Procedure

After the application, potential participants were screened, provided with an oral explanation of the study, and called to verify the inclusion and exclusion criteria (see *Figure 6*). When a nurse was still willing to participate, an inclusion appointment was scheduled. This intake took place between one and three days before the first night-shift series. During the intake, the Informed Consent was signed, participants were offered an explanation of all of the study's procedures, provided materials, shown how to perform the tasks, and informed about the group in which they were classified. In addition, participants filled in a demographic questionnaire and the PSQI (T0). Due to the real-life setting and in order to avoid biases, the nurses were told that it is unknown which method of sleeping is more effective (sleeping once or twice). The participants worked within a period of four to eight weeks for two night-shift series of at least three consecutive nights, though some participants worked more night shifts within a series when they were scheduled. The first series was the first measurement point (T1) and the second was the second measurement point (T2). After the two night-shift series, an exit interview was conducted in which the participants could share their thoughts and feelings about the study (T3). They also handed in the materials (for a detailed description, see paragraph *2.4 Exit interview*). *Figures 7a, 7b and 7c* display an overview of the total study design, from inclusion to the exit interview. After the interview, the participation ended.

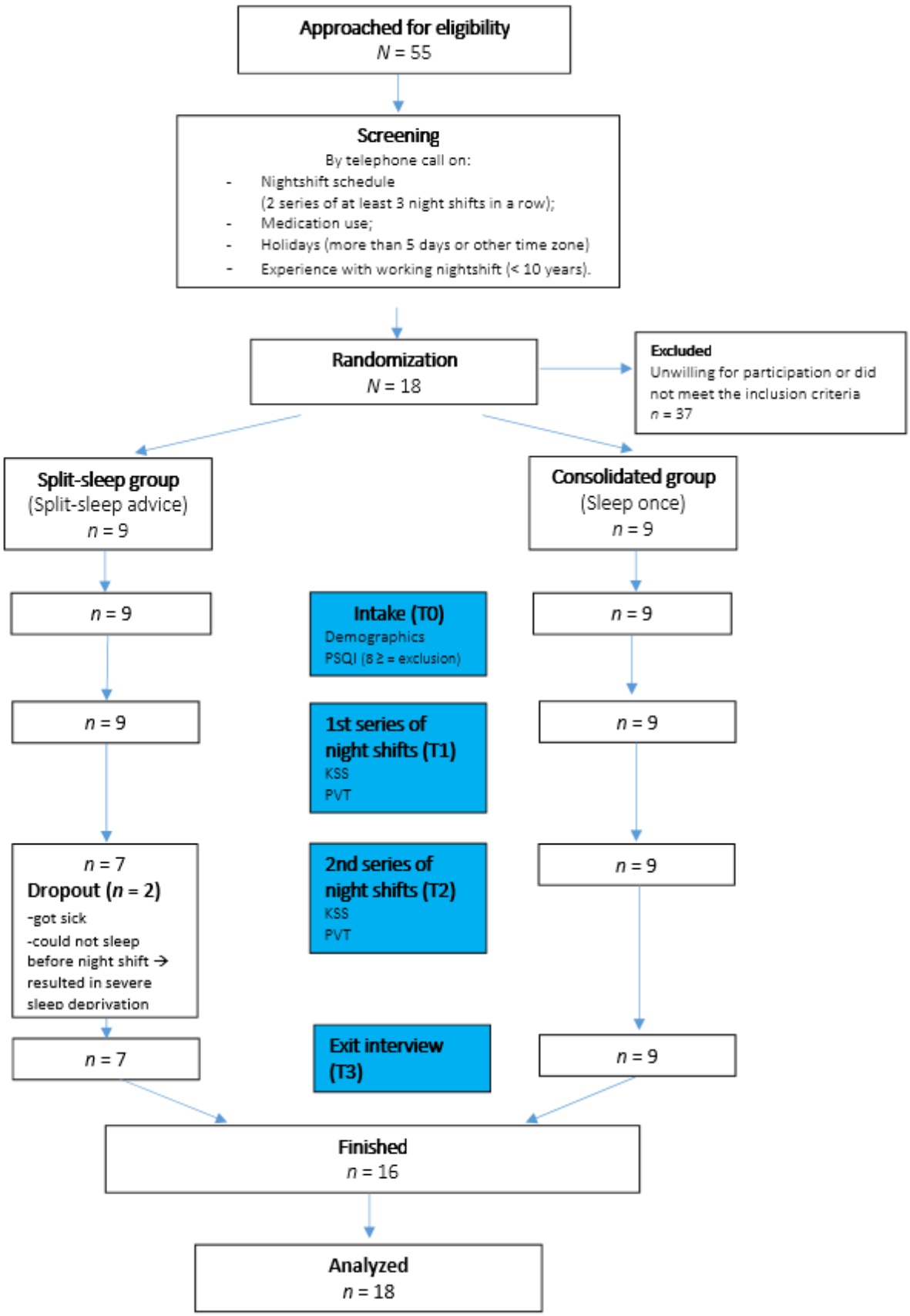


Figure 6. Study design.

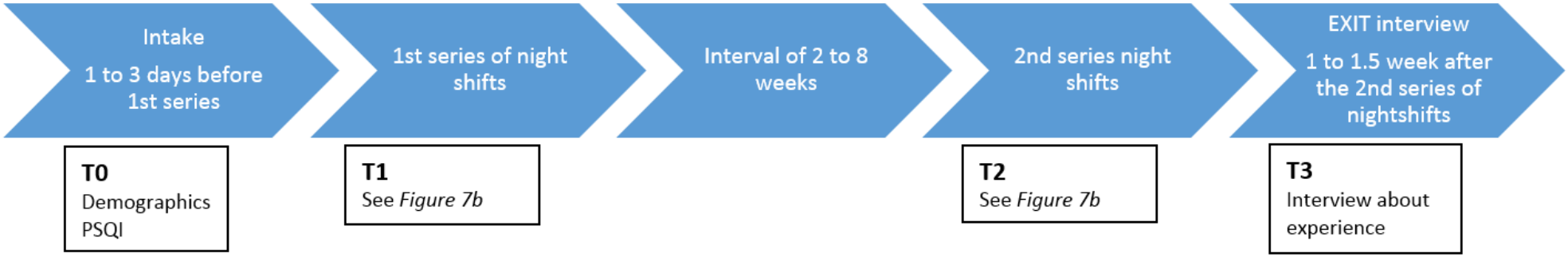


Figure 7a. Study overview with outcome measures.
Note. PSQI = Pittsburgh sleep quality index.

1st night shift	2nd night shift	3rd night shift
Before the shift (around 10.30 PM)	**Before the shift (around 10.30 PM)**	**Before the shift (around 10.30 PM)**
Karolinska Sleepiness Scale (KSS)	Karolinska Sleepiness Scale (KSS)	Karolinska Sleepiness Scale (KSS)
Psychomotor vigilance task (PVT)	Psychomotor vigilance task (PVT)	Psychomotor vigilance task (PVT)
Halfway during the shift (between 4 and 5 AM)	**Halfway during the shift (between 4 and 5 AM)**	**Halfway during the shift (between 4 and 5 AM)**
Karolinska Sleepiness Scale (KSS)	Karolinska Sleepiness Scale (KSS)	Karolinska Sleepiness Scale (KSS)
Psychomotor vigilance task (PVT)	Psychomotor vigilance task (PVT)	Psychomotor vigilance task (PVT)
Short after the shift (around 8 AM)	**Short after the shift (around 8 AM)**	**Short after the shift (around 8 AM)**
Karolinska Sleepiness Scale (KSS)	Karolinska Sleepiness Scale (KSS)	Karolinska Sleepiness Scale (KSS)
Psychomotor vigilance task (PVT)	Psychomotor vigilance task (PVT)	Psychomotor vigilance task (PVT)

Figure 7b. Time line of measures during a series of nightshifts
Note. 3 nightshifts are elaborated, sometimes there are 4 or 5 but exact the same measures are collected.

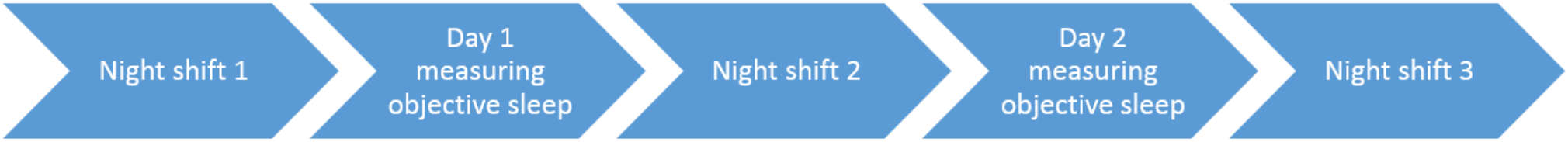


Figure 7c. Overview objective sleep measures

2.3 Measures

2.3.1 Objective sleep

The objective sleep was measured with Philips Respironics' Actiwatch Spectrum PRO (Philips Respironics, n.d.): a wrist-worn watch that measures sleep through an accelerator and is validated against the gold standard, the polysomnography (PSG) (Kushida et al., 2001; Endinger, Means, Stechuchak, & Olsen, 2004; Mantua, Gravel, & Spencer, 2016). Participants were instructed to wear the watch as much as possible on days and nights during their study participation. They were told to dismiss the watch at work (due to hygiene reason), during showering, exercising and swimming (the watch is not waterproof). Participants were asked to press the event-marker button on the watch every morning when they tried to fall asleep and in the afternoon when they got out of bed. In addition, the split-sleep group was asked to press the marker button in the evening when they tried to fall asleep and when they got out of bed again. Furthermore, participants were asked to keep a sleep diary during the study. When there were no marker-button data present, the bed and rise times were taken out of the diary.

Primary outcome variables were the average daily TST (sleep time in minutes) during the night shifts and the two nights after both night-shift series. Secondary outcome variables (monitored for explorative purposes) were the average daily SOL and sleep efficiency (SE) during and two nights after the night shifts (for both groups). In addition, the SOL and SE during the second sleep opportunity were calculated for the split-sleep group as well. The SOL is the time between lying in bed and falling asleep in minutes, while the SE is a percentage: 100% x TST / total time in bed (TIB). *Figure 7c* presents an overview of the objective sleep measures.

In order to create a valid comparison with the consolidated group, the split-sleep group's TST after a night shift (green circles in *Figure* 8) and TST before the next night shift (red circles in *Figure* 8) were summed up. The SOL and SE were not summed, as this does not create a valid comparison. In addition, due to possible differences over successive night shifts, only sleep data between the first and second night shift, and data between the second and third night shift (which all participants provided) were included for analyses, in order to create a valid comparison (black crosses represent excluded data in *Figure 8*). The sleep data of the included nights were averaged.

2.3.2 Alertness

The alertness was measured with the psychomotor vigilance task (PVT): a reaction-time task that was developed by Wilkinson & Houghton (1982) and which is often used in sleep and performance studies (e.g., Jackson et al., 2014). The start screen is black with a white rectangle in the middle. The aim is to tap the screen as quickly as possible when the numbers appear in the rectangle. The test lasts ten minutes and was executed with the Joggle Research application (Joggle Research, n.d.) on an iPad.

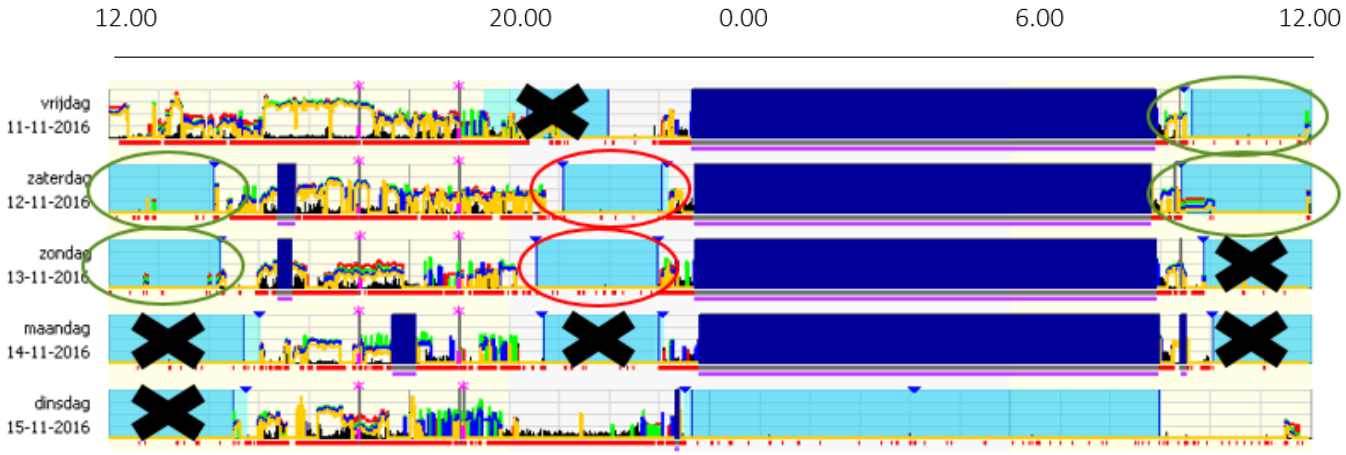


Figure 8. Overview data analyses of objective sleep. At the top, the time of day is presented. The dark blue bars represent the night shift, the light blue bars represent sleep intervals, the green circles represent sleep data after the night shift, the red circles represent the data before the next night shift and the black crosses represent data that were excluded.

The PVT was performed three times during the night shift: at the beginning, (pre) middle (mid) and end (post) (T1 and T2, see *Figure 7a, 7b*). The outcome measures were the number of lapses (reaction time >500 ms) and mean response time (1/reaction time in s).

For both groups, data from the first night were excluded, as split-sleep for the split-sleep group had not yet taken place. As the amount of night shifts differed between participants and in order to eliminate the influence of successive night shifts (Folkard, Lombardi & Tucker, 2005), only data from the second and third night shift were included for analysis (which all participants provided). The remainder of the data were excluded. Subsequently, the data of the three time points (pre, mid and post night shift) of the second and third night shift were averaged.

2.3.3 Subjective sleepiness

Subjective sleepiness was measured with the Karolinska sleepiness scale (KSS; Åkerstedt and Gillberg (1990), which consist of one question ("how sleepy or alert do you feel at this moment?") and a one-dimensional scale of sleepiness/alertness with nine response options. A low score indicates alertness and a high score represent sleepiness (see Table 2). The KSS is frequently used in the measurement of subjective sleepiness when standard objective measures are not feasible. The scale is validated against EEG, which is considered to be the golden standard (Kaida et al., 2006). During the study, subjective sleepiness was measured at the same times as alertness (T1 and T2, see *Figure 7a, 7b*). The KSS was administrated by an online survey, from which data were collected with Verint Enterprise software.

Similarly to alertness, only data from the second and third night shift were included for analysis. In addition, data from the three time points of the included data of both series were averaged.

Table 2

The Karolinska Sleepiness Scale (KSS)

1	Extremely alert
2	Very alert
3	Alert
4	Rather alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy, but no effort to keep awake
8	Sleepy, some effort to keep awake
9	Very sleepy, great effort to keep awake, fighting sleep

2.4 Exit interview

At the end of the study, an interview was scheduled with participants in order to explore their experiences, attitudes, subjective norm, perceived behavioural control and intentions with the split-sleep schedule (T3 in *Figure 7a*). Participants who were assigned to the consolidated group were asked to imagine that they had followed the split-sleep schedule. These interviews were used to develop recommendations for the implementation of the split-sleep schedule and were semi-structured. An interview protocol was written (see Appendix A), though the questions could be posed in a different order and further questions could be asked in order to gain more information (Tong, Sainsbury, & Craig, 2007). The questions were based on the TPB and the important topics were attitudes towards the split-sleep schedule (e.g., “what are the positive and negative sides of the split-sleep schedule?”), subjective norm (e.g., “what do you think your direct environment thinks of the split-sleep schedule?”), perceived behavioural control (e.g., “how difficult was it to comply with the schedule on a scale from 1 to 10, where 1 stands for very easy and 10 for extremely difficult?”) and their intentions (e.g., “would you continue with the split-sleep schedule?”). Finally, participants were asked basic questions regarding their sleep and health in order to gain more insight into the current sample characteristics and make it easier to interpret results. Participants were asked to give their answers unrelatedly to the split-sleep schedule. Participants self-rated their sleep and health on a scale from 1 to 10, where 1 is very poor and 10 is extremely good. The interviews were recorded and subsequently translated into transcripts.

2.5 Analyses

The analyses were made in IBM SPSS statistics (version 23). In addition, the Actiwatch data were imported with the Respironics Actiware 5 software (version 6.9). During the study, two participants dropped out. The available data from the two dropouts were averaged and included in the analyses in order to prevent a positive overestimation of the results. When data were missing regarding alertness and subjective sleepiness, it was assumed that these data were missing at random, as the tests were frequently aborted and it was assumed that the nurses had to do so in order to take care of patients. By averaging the data, the missing data were averaged out, thereby not influencing the result in an over- or underestimation.

2.5.1 Quantitative analyses

For the primary and secondary quantitative outcome measures (objective sleep, alertness and subjective sleepiness), data were explored by boxplots. When an outlier occurred, the Cook's distance test was performed in order to observe the outlier's impact on the model. According to Cook and Weisberg in Fields (2009), when the influence is more than one, the outlier had to be removed. However, none of the outliers were removed. After reviewing a histogram, it was concluded that all measures were not normally distributed. For all primary outcome variables medians, interquartile ranges and Mann-Whitney tests were therefore calculated and performed. For the secondary outcome variables, medians, interquartile ranges and Mann-Whitney tests were calculated and performed on data from post night shift and two nights after the night-shift series for and between both groups. Furthermore, for explorative purposes, the SOL for the split-sleep group between post night and pre night shift were tested with a Wilcoxon Signed rank test. As the split-sleep group had to fall asleep two times, no analyses were made for the total objective sleep regarding the SOL. In addition, due to the influence of the SOL on SE (the SE becomes underestimated when participants have less total time in bed in one sleep opportunity), no statistical tests performed for SE either.

2.5.2 Qualitative analyses

The interviews were transcribed and were coded in a deductive manner. A coding scheme with topics and codes was designed by using the themes of the TPB and the interview questions (Table 3 and Appendix B). Each topic was assigned a colour and used to highlight specific sections in the transcripts according to the topic. These fragments were translated into labels, followed by a quote. When a label occurred more than once, this was noted after the label. During the process, new codes were developed when they fitted the data better. When all of the transcriptions were reviewed, overlapping labels were combined into a more general label.

Table 3

Part of coding scheme

Topic	Codes	Label	Quote
Attitude split-sleep	Thoughts		
	Positive attitudes		
	Pro's		
	Cons		
	Differences during night shift		
Subjective norm split-sleep	Attitudes of direct environment		
	Attitudes for the future		
	Influence on intentions		

Note. Left column consists of topics of the Theory of Planned Behaviour. One column to the right contains the drafted codes. The other two columns were completed during the coding process.

3. Results

This chapter presents the results of the conducted research. Firstly, the sample is described regarding characteristics, sleep and health, and concludes with a description of the dropouts. Secondly, the results on effectiveness are reported. Finally, the results of the qualitative section regarding the experiences, attitudes, subjective norm, perceived behavioural control and intentions are presented.

3.1 Sample description

The sample consisted mostly of young female nurses who worked full time and had no more than seven years of experience with working night shifts (Table 4). In general, the participants reviewed their sleep as fine during a series of night shifts before the study (Table 5). None of the participants reported sleep problems. Variable sleep patterns due to work schedule, processing stressful day events and behaviour-related reasons (e.g., going to bed too late or exercising late) were arguments for not giving a perfect score. In addition, the nurses reported being healthy and having no serious health complaints (Table 5). Two participants had mild health complaints, namely small bladder and bowel issues.

In general, participants assumed that working night shifts is not healthy, which was mostly based on their own complaints or that of their colleagues. Participants had limited knowledge about long-term risks, though breast cancer was frequently named. The risk of unwanted health outcomes is occasionally discussed among colleagues, mostly when complaints occur. Finally, nurses who have sleeping problems and/or health complaints during a night-shift series work fewer night shifts compared to relatively good sleepers. Therefore, only nurses who were good sleepers during the night-shift series could be included for the current study.

Table 4

Characteristics of participants divided in total, experimental and consolidated group

	Total (*N* = 18)		Split-sleep group (*n* = 9)		Consolidated group (*n* = 9)	
Variable	*n* (%)	*M* (*SD*)	*n* (%)	*M* (*SD*)	*n* (%)	*M* (*SD*)
Gender						
Female	17(94.4)		8(88.9)		9(100)	
Male	1(5.6)		1(11.1)		0(0)	
Age		25.11(1.98)		25.11(2.26)		25.11(1.83)
Years of night shift experience		3.36(2.01)		3(1.79)		3.72(2.25)
Working days per week		4.94(0.42)		5.13(0.35)		4.78(0.44)

Note. n = numbers; *M* = means; *SD* = standard deviations.

Table 5

Numbers and percentages of the self-rated score regarding sleep pattern and health (n = 16)

Topic	Score 1 to 10	Frequency *n* (%)
Sleep pattern (missing 2)	4	1 (6.25)
	7	6 (37.5)
	8	6 (37.5)
	9	3 (18.75)
Health (missing 2)	6.5	1 (6.25)
	7	3 (18.75)
	7.5	2 (12.50)
	8	3 (18.75)
	9	4 (25.00)
	10	3 (18.75)

Note. n = numbers; % = percentages; Score scale was between 1 and 10, where 1 is very poor and 10 extremely good. Only the named numbers are presented.

3.1.1 Dropouts

The two dropouts were questioned afterwards about their reasons for dropping out. They named not falling asleep or sleeping too short during the evening nap and therefore becoming seriously sleep deprived (*"… 's avonds kwam ik niet in slaap… [ik heb maximaal] een half uurtje gedoezeld… op een gegeven moment kom je al met al best wel wat uurtjes [slaap] te kort… En dat breekt je dan wel op na drie nachten…"*). Reasons for not sleeping or having difficulty with falling asleep during the evening nap were feeling too alert and not feeling tired, being afraid to wake up very tired and being afraid to oversleep. Strategies that the drop-outs applied in trying to fall asleep during the evening were being active or doing little to nothing during the day (e.g., *"…dan ging ik mezelf een beetje moe maken, dus flink opstaan en flink wat doen…ik dacht van... misschien slaap ik dan wel… de dag erna dacht ik van dan doe ik vrij weinig, ga ik mezelf een beetje sloom houden… [maar het hielp niet]"*).

In addition to the difficulty of falling asleep and becoming sleep deprived, the drop-outs experienced difficulty in getting out of bed during the day or evening, as well as physical complaints (e.g., feeling as if having a hangover and being very tired). When the drop-outs did fall asleep and woke up during the evening, they felt as if it was the middle of the night. One of the drop-outs sleeps well during the day and therefore concludes that the split-sleep schedule is not for everyone: *"Nee ik denk dat gesplitst slapen gewoon niet voor mij is weggelegd… Ik slaap ook gewoon super overdag".*

3.2 The effectiveness of the split-sleep schedule

Prior to the tests, it was expected that the primary outcomes would entail that the split-sleep schedule led to more objective sleep, higher alertness and lower subjective sleepiness during the night shifts. The results show no significant differences for objective sleep (Table 6 and boxplots in appendix C). However, a trend was found for TST two nights after the night-shift series. Therefore, it appears that on the two nights after the night-shift series, the split-sleep group had more TST compared to the consolidated group (p = 0.09). In addition, no differences in alertness were observed. Nevertheless, a trend towards significance was again found for the number of lapses. It appears that the split-sleep group had fewer lapses than the consolidated group (p = 0.09), which indicates a higher alertness. Both trends indicate that there is a possibility of finding a difference between both groups with the planned total sample of 40 nurses. Finally, no differences were found for subjective sleepiness between both groups.

The SOL and SE formed the secondary outcome variables and were analysed for explorative purposes (Table 6 and boxplots in appendix C). No differences were found between the split-sleep and consolidated group regarding SOL and SE. However, there was a significant difference within the split-sleep group between the SOL post (*Mdn* = 4.50) and SOL pre (*Mdn* = 7.50) night shift, Z = -1.820, p = 0.035.

Table 6

Medians, interquartile ranges and p-values for objective sleep, alertness and subjective sleepiness between groups

	Split-sleep group (*n* = 9) *Mdn* (IQR)	Consolidated group (*n* = 9) *Mdn* (IQR)	Test statistic *U*	*p*-values
Primary outcomes				
Objective sleep				
TST (in min)	370.50(358.00;395.00)	360.50(330.75;373.50)	31.00	0.201
TST two nights after night-shift series (in min; missing 1)	477.50(454.50;500.88)	459.75(411.50;481.17)	22.00	0.089
Alertness				
Number of lapses (RTs > 500 ms)	5.22(2.17;6.58)	8.42(5.08;11.83)	25.00	0.086
Response time (1/RT in s)	3276.17(3220.83;3479.07)	3230.81(2798.85;3512.75)	37.00	0.379
Subjective sleepiness				
KSS score (missing 2)	5.00(4.79;5.26)	4.75(4.58;5.33)	25.00	0.755
Secondary outcomes				
Objective sleep				
SOL post shift (in min)	4.50(2.50;5.50)	4.00(1.50;6.33)	38.500	0.430
SOL Pre shift (in min)	7.50(4.33;13.50)	Not applicable	Not applicable	Not applicable
SOL two nights after night-shift series (in min; missing 1)	6.00(2.63;11.50)	6.50(5.00;21.00)	28.000	0.221
SE post shift (in percentage)	89.06(84.69;89.98)	84.98(77.95;89.16)	Not applicable	Not applicable
SE pre shift (in percentage)	76.78(73.74; 79.91)	Not applicable	Not applicable	Not applicable
SE two nights after night shift-series (in min; missing 1)	87.15(82.99; 89.18)	83.75(81.84;88.13)	23.000	0.106

Note. Significance level for the p-value was set on 0.05. *n* = numbers; *Mdn* = median; IQR = interquartile range; *U* = Mann-Whitney test statistic; TST = Total sleeping time; min = minutes; RT = reaction time; s = seconds; KSS = Karolinska sleepiness scale; SOL = Sleep onset latency; SE = Sleep efficiency.

3.3 Experience and attitudes with the split-sleep schedule

The results of the interviews are reported for both conditions separately, as both groups provided different data. The split-sleep group provided the actual experiences with the split-sleep schedule, which can be used to improve the split-sleep schedule. The consolidated group provided data about their perceived experiences, which provides important recommendations for promotion, as in real life most shift workers will not first test the split-sleep schedule during a study.

3.3.1 Attitudes towards the split-sleep schedule split-sleep group

Thoughts

In general participants in the split-sleep group were quite positive about the split-sleep schedule (Table 7). Participants were more positive when they fell asleep easily: *"…maar vaak sliep ik wel, omdat je 's ochtends kort slaapt, dan val je 's avonds toch wel in slaap"*. Two participants had to adapt to the split-sleep schedule, especially to the sleep opportunity during the evening.

Table 7

Thoughts of participants towards the split-sleep schedule in the split-sleep group (n = 7)

Thoughts	*n* (%)	Sample quote
Feasible	2 (28.6)	"*Op zich wel redelijk [te doen]".*
Acceptable	3 (42.9)	*"Prima, dat ga ik voortaan altijd doen…"*
Adapt to the split-sleep schedule	2 (28.6)	*"Wel even wennen dat je verplicht naar bed moet... eerst had ik meer zoiets van moet ik nu alweer gaan slapen [ik merkte] een beetje frustratie… [Tijdens de tweede serie] had ik meer zoiets van, nu moet ik gaan slapen dus dan deed ik dat maar gewoon"*

Note. n = frequency; % = percentages.

Advantages

Participants mentioned a wide range of advantages, which are summarized in Table 8. One important advantage, which was named frequently, was enjoying more of the day (e.g., *"ik merk wel dat ik iets meer aan mijn dag heb…"*). Two participants found it easier to have a social life besides work when following the split-sleep schedule:

> *"Ligt eraan, als mijn vriend vrij is dan heb je die dag 's middags nog wat aan elkaar. Dan kun je 's middags inderdaad nog wat afspreken of doen. 's Avonds kun je gewoon minder doen... Dus je hebt toch iets meer een sociaal leven als je twee keer slaapt".*

In addition, participants noticed positive effects during their night shifts. For example feeling more alert during the night shift or felt better rested. However, workload at the department during the night shift may seem to play a role as well: *"…op deze afdeling is het echt ontzettend druk in de nachtdienst… Je bent de hele tijd bezig en we hebben eigenlijk helemaal geen tijd om in te kakken".*

One participant provided an explanation for the increased alertness during the night shift. He said: 'since you just got out of bed in the evening it feels like a morning to your body': *"als je ervoor nog een klein beetje slaapt dan heb je het idee dat je aan een nieuwe dag begint… je houdt je lichaam een beetje voor de gek, …maar dat werkt wel… qua wakkerheid en energie, scheelt dat een heel stuk".*

In addition, participants found it easier to plan meals and to eat. With the split-sleep schedule one participant was hungrier during dinner time, and therefore ate more than usually when working night shifts, resulting in not feeling hungry during the shift. The split-sleep schedule helped with eating regularly (like they would normally do outside their night shifts) as well.

> *"Als je 's avonds wakker wordt… dan heb ik niet altijd honger. [Met als gevolg] dat je dan eigenlijk te weinig gegeten hebt voordat je naar de nachtdienst gaat. Maar dat had ik bij deze reeksen niet... want je bent dan al [een tijdje] wakker en dan ga je een keer eten. Dus voor mij was het fijner... je eetpatroon is ook eerder normaal, zoals je het anders zou doen...".*

Other important advantages were: getting extra sleep, having more regularity, and two participants found it easier to shift back to their normal rhythm or did so faster. However, the experienced difference in shifting seems personal, since others did not notice any differences when shifting back: *"Het terug omschakelen is nog steeds een ramp, maar ik weet niet of dat te maken heeft met het gesplitst slapen of met de nachtdienst…".* Finally, one participant said that the split-sleep schedule helped him against oversleeping during the day and therefore he felt less tired.

Table 8

Advantages named by the split-sleep group (n = 7)

Advantages	Expressions	*n* (%)	Sample quote
Enjoy more of the day	See more of the day	4 (57.1)	*"… je ziet wat meer van de dag…"*
	Feel fitter during the day	2 (28.6)	*"je bent wat fitter overdag…"*
	See day light	2 (28.6)	*… in de winter zie je dan nog een beetje daglicht…"*

(continued)

Advantages	Expressions	*n* (%)	Sample quote
Easier to have a social life		2 (28.6)	*"… je kunt 's middags inderdaad nog wat afspreken… 's avonds kun je gewoon minder doen… dus je hebt toch iets meer een sociaal leven als je 2 keer slaapt".*
Feeling positive effects during the night shift	More alert in beginning/during the night shift	3 (42.9)	*"Toch had ik 's nachts het idee dat ik iets meer alert was".*
	Feeling better rested	2 (28.6)	*"… maar verder was ik 's nachts wel beter uitgerust".*
	First part of the night is less difficult than before	1 (14.3)	*"… en dat is met 2 keer slapen, het tweede gedeelte blijft zwaar. Maar met 1 keer slapen dan had ik altijd al dat het eerste gedeelte al rot was".*
	Easier to stay awake during the night shift	1 (14.3)	*"… het wel wat makkelijker om wakker te blijven, tijdens je nachtdienst".*
	Feeling less tired in the morning	1 (14.3)	*"… waardoor je 's ochtends minder moe bent…"*
	Depends on workload department	2 (28.6)	*"… deze afdeling is wel echt ontzettend druk in de nachtdienst… Je bent de hele tijd bezig en we hebben geen tijd om in te kakken".*
Easier to plan meals and to eat		3 (42.9)	*"… je bent al [een tijdje] wakker en dan ga je eten. Dus voor mij was het fijner… je eetpatroon is eerder normaal, zoals je het normaal zou doen…"*
Extra sleep		1 (14.3)	*"… met nachtdiensten kan ik sowieso niet goed slapen… dan ben ik heel blij als ik 's avonds nog even moet gaan slapen".*
Created more regularity		1 (14.3)	*"… maar echt in een reeks van 3 of 4 dan is het wel veel fijner. Dan heb je veel meer rust en regelmaat".*
Easier or faster shifting back to normal rhythm		2 (28.6)	*"De dag dat ik uit de nachtdienst kom… dan ga ik altijd een paar uurtjes slapen en dat komt meer overeen met in twee delen slapen dan in één stuk… je bent eerder teruggeschakeld".*
Helped against oversleeping		1 (14.3)	*"Ik merk voor mezelf… dat ik eigenlijk gewoon wat strenger voor mezelf ben… anders ga je over je slaap grens heen en dan blijf je moe".*

Note. n = frequency; % = percentages.

Disadvantages

Participants mentioned a number of disadvantages as well. These are summarized in Table 9. Although two participants viewed the influence of the split-sleep schedule on their social lives as an advantage, four participants thought the split-sleep schedule had a rather negative influence on their social lives. Since the participants woke up when most people were working and went to bed when their environment was off duty. Participants that viewed this as a disadvantage were generally more active during the evening rather than during the day.

> *"...vooral het sociale leven, het leven wat ik met mijn vriend heb.... we eten samen en daarna ga ik weer redelijk snel slapen en dan is hij net thuis en dan spreek je elkaar maar heel even... sommige mensen die tot 17.00 uur slapen kunnen dan 's avonds nog gewoon dingen gaan doen, maar als je zo gesplitst [slaapt] dan [kan dat niet]…, 's middags doe je ook niet echt iets...".*

Furthermore, being preoccupied with sleep, having to change daily structure regarding eating and activities, finding it hard to get out of bed, and experiencing physical complaints (e.g., feeling nauseous) were reported disadvantages. Finally, one participant did not really see disadvantages and thinks it is very personal how long and at what times one is comfortable sleeping.

Table 9

Disadvantages named by the split-sleep group (n = 7)

Disadvantages	*n* (%)	Sample quote
Social life	4 (57.1)	*"… mensen kunnen dan 's avonds nog dingen gaan doen…'s middags doe je ook niet echt iets…"*
Preoccupied with sleep	2 (28.6)	*"je bent dan heel veel bezig met slapen…je bent continu aan het rekenen… om je uren te halen".*
Having to change daily structure	2 (28.6)	*"… je moet je eetpatroon aanpassen... en 's avonds naar bed gaan terwijl je nog van alles wil gaan doen".*
Difficulty getting out of bed	2 (28.6)	*"… alleen ik vond het lastig om dan weer uit bed te moeten".*
Physical complaints	1 (14.3)	*"… om half 2 ging ik er uit… dan was ik hartstikke misselijk…"*
None, it is personal	1 (14.3)	*"Nee, ik denk dat het gewoon ligt aan hoe iemand slaapt. Als iemand gewoon in 1 ruk tot 18.00 uur slaapt dan denk ik dat dat gewoon goed is".*

Note. n = frequency; % = percentages.

3.3.2 Subjective norm towards the split-sleep schedule split-sleep group

Almost half of the participants thought that following the split-sleep schedule was harder for their direct environment compared to consolidated sleep (Table 10). The main reason was being less sociable, since participants went to bed in the evening when they usually had some quality time with their partner. Furthermore, some practical issues (e.g., dinner had to be advanced in order to have enough time to sleep) and following the sleep schedule in weekends were perceived as factors that made it more difficult for the environment:

> *"Nou ik heb misschien ook de pech gehad dat ik altijd in het weekend nachtdiensten heb gehad, want doordeweeks zou het geen probleem zijn. Want dan is hij toch aan het werk als ik slaap, maar in het weekend dan is hij natuurlijk thuis en dan slaap ik… En [in de middag] wou hij me persé mee naar buiten hebben en ik dacht nee, daar heb ik helemaal geen zin in en moet dat nou. Ik ben nu aan het wennen dat ik vijf uur geslapen heb en doe maar een beetje rustig aan".*

The other half said that their partner found it acceptable towards the split-sleep schedule, since they work only one night shift series a month and thought it is their own responsibility. Half of the participants thought their partner would not mind if they continue with the split-sleep schedule, since they work not only night shifts. Two participants were directly asked and said that the opinion of their partner would withhold them to continue with the split-sleep schedule (e.g., *"Ik zou het wel zo blijven doen, dan"*). The other were not asked directly, however no one mentioned that they would be influenced by their direct environment regarding their decision.

Table 10

The subjective norm towards the split-sleep schedule in split-sleep group (n = 7)

Subjective norm	Expression	*n* (%)	Sample quote
More difficult for direct environment	Less sociable	3 (42.9)	*"Ik denk dat het iets lastiger is geweest…om daarin zijn weg te vinden en zijn planning aan te passen".*
	Advance dinner	1 (14.3)	*"… je moet je eetpatroon aanpassen... en 's avonds naar bed gaan terwijl je nog van alles wil gaan doen".*
	Harder in weekends	1 (14.3)	*"… doordeweeks zou het geen probleem zijn, want dan is hij aan het werk…nu [in de middag] wilde hij me persé mee naar buiten hebben… ik had daar helemaal geen zin in. Ik [dacht] ben net aan het wennen aan 5 uur slaap…doe maar beetje rustig aan".*

(continued)

Subjective norm	Expression	*n* (%)	Sample quote
Neutral	Own responsibility	1 (14.3)	*"… op zich vindt hij het niet heel erg… hij accepteert dat wel. Hij zegt: jij moet zorgen dat je fit bent…"*
	Acceptable	3 (42.9)	*"… op zich vindt hij het niet heel erg en hij zegt ook van ik ben blij dat het niet altijd is…"*
Subjective norm towards continuation			
Would not mind		4 (57.1)	*"neuh dat vinden ze niet erg…"*
Influence on implementation			
None		2 (28.6)	*"Ik zou het wel zo blijven doen".*

Note. n = frequency; % = percentages.

3.3.3 Perceived behavioural control towards the split-sleep schedule split-sleep group

With an average score of 3.4 on a scale from 1 to 10, participants found the schedule quite easy to follow (Table 11).

Table 11

Frequencies and percentages of the self-rated score regarding difficulty executing the split-sleep schedule in the split-sleep group (n = 7)

	Score (1 to 10) (missing 2)	Frequency *n* (%)
Perceived behavioural control	1.5	1 (14.3)
	2	2 (28.6)
	3	1 (14.3)
	4	1 (14.3)
	4.5	1 (14.3)
	7	1 (14.3)

Note. n = frequency; the score scale was between 1 and 10, where 1 is very easy and 10 extremely difficult. Only the named numbers are presented.

When participants fell asleep easily they rated the split-sleep schedule with a low score (e.g., *"Ik vond het echt niet moeilijk namelijk. Ik kan gewoon goed slapen"*; Table 12). One participant scored far above the average and gave a seven. Reasons were feeling tired during the day and finding it hard to go back to bed again, because she wanted to spent time with her partner. Factors that made it more difficult were: social life, not feeling rested after the first sleep opportunity (e.g., *"…als je om 13.30 uur wakker wordt dan heb je 5 uurtjes geslapen, dus mijn lichaam denkt dan van, 'ik moet nog heel even"*), bounded to specific sleep times, and working more than 2 or 3 night shifts in a row:

> *"... de eerste nachtdiensten zou ik het een drie geven of zo, dan is het wel goed te doen... dan heb ik gewoon nog meer energie... Maar [het is] niet zo gemakkelijk als in één stuk slapen. [maar na drie nachtdiensten]… was het toch echt wel een zes/zeven... Want dan wil je gewoon echt een keer lang slapen zeg maar. Iedere keer die korte stukjes, en op een gegeven moment ben je gewoon gebroken... het ritme wat je omgooit, het kost dan meer energie".*

Personalizing the sleep schedule to wishes of the participants was an important factor to make it easier for participants to follow the split-sleep schedule. For example, shorten the nap in the evening (so there is more time to clean the kitchen after dinner), take the nap earlier in the evening (so there is more time to prepare for the night shift), and flexible implementation of the sleeping times. In addition, living alone and change planning (e.g., plan less activities during the evening and plan activities during the day) made it also easier to follow the schedule.

Table 12

Perceived behavioural control towards the split-sleep schedule in split-sleep group (n = 7)

Perceived behavioural control	*n* (%)	Sample quote
Factors that make it easy		
Fell asleep easily	2 (28.6)	*"Ik vond het echt niet moeilijk namelijk. Ik kan gewoon goed slapen".*
Factors that make it difficult		
Social life	3 (42.9)	*"Ik denk dan dat … het sociale aspect het misschien wat lastiger maakt. Dat je 's avonds geen sociaal leven zou kunnen hebben".*
Not feeling rested	1 (14.3)	*"… als je om 13.30 uur wakker wordt dan heb je 5 uurtjes geslapen, dus mijn lichaam denkt dan van, 'ik moet nog heel even".*

(continued)

Perceived behavioural control	*n* (%)	Sample quote
Bounded to specific sleep times	1 (14.3)	*"Maar het is was niet super gemakkelijk, omdat je ook soms denkt ik wil niet gebonden zijn aan bepaalde tijden dat ik moet slapen".*
Working more than 2 or 3 night shifts in a row	1 (14.3)	*"… want de eerste nachtdiensten … is het wel goed te doen... dan heb ik gewoon nog meer energie... Maar niet zo gemakkelijk als in 1 stuk slapen. En de laatste 2 nachtdiensten… dan wil je gewoon echt een keer lang slapen zeg maar. Iedere keer die korte stukjes dan op een gegeven moment dan ben je gewoon gebroken... het ritme wat je omgooit, het kost dan meer energie".*
Factors that make the schedule easier		
Personalize the sleep schedule	3 (42.9)	*"… ja nou dan zou je 's avonds die tijd moeten verkorten..."* or *"Ik vond het wel fijn om van 18:00 tot 20:00 te slapen [i.p.v. 19.00 tot 21:00 uur".*
Living alone	1 (14.3)	*"… ik kan mijn vriend dumpen. Hahaha dan is het makkelijker om naar bed te gaan".*
Change planning	2 (28.6)	*"Je hebt ook een huishouden en dingen te doen, maar als je dat minder hebt dan ga je misschien ook sneller 's avonds ook naar bed".*

Note. n = frequency.

3.3.4 Intentions split-sleep group

All participants were open to continue with the slit-sleep schedule when they are not able to sleep enough during the day, have no activities planned during the evening, wanting to enjoy more of the day during winter or with nice weather, when the sleep schedule is personalized, and finally when the night shift series is short, e.g., only 2 or 3 night shifts (Table 13). One participant would try to continue with the split-sleep schedule however, would replace the nap in bed for a resting period on the couch. Furthermore, three participants were not planning on continuation of the split-sleep schedule when they slept enough, since it is closer to their rhythm or when they have already planned activities. Participants would not postpone or advance these planned activities. Furthermore, one participant is only planning for implementation when the current study proves that the split-sleep schedule is effective. Finally, one participant does not care about the health influences and will not be influenced by the results of the current study. In her opinion the health damage is already done:

> *"neuh, want dan is het kwaad toch al geschied, hahaha… dat is hetzelfde als een patiënt tegen mij zegt met longkanker ik ben gestopt met roken dan denk ik 'ja die 2 maanden extra maakt dan ook niets meer uit'".*

Table 13

Intentions towards continuation with the split-sleep schedule by split-sleep group (n = 7)

Intentions	*n* (%)	Sample quote
Open for continuation when the following conditions are met		
Unable to sleep enough during the day	2 (28.6)	*"… als ik toch weer om 13.00 uur wakker ben, … dan kan ik beter 's avonds weer even gaan liggen. Anders heb ik gewoon te weinig slaap".*
No activities planned during the evening	1 (14.3)	*"Ik denk niet dat ik het altijd zou doen, want ik heb natuurlijk [soms ook andere dingen te doen]".*
Enjoy more of the day during winter or with nice weather	2 (28.6)	*"…Maar als het een keer mooi weer is en ja ik denk van ik wil even van de zon genieten dan zou ik wel eerder mijn wekker zetten en 's avonds nog een keer naar bed gaan ja".*
Personalisation of the split-sleep schedule	3 (42.9)	*"…maar ik denk wel dat als ik het nu los van die studie toe ga passen… dat je dan wat flexibeler kunt zijn in de tijden".*
Short night shift series	1 (14.3)	*"Nou als ik bijvoorbeeld 2 of 3 nachtdiensten had dan zou ik het misschien wel doen…want ook omdat je dan makkelijker terug schakelt en … dan is dat wel te doen denk ik, ook privé… "*
Resting on the couch rather than sleeping in bed	1 (14.3)	*'s avonds even rusten [op de bank] zeg maar... niet dat je verplicht naar bed moet".*
Not willing for continuation when		
Sleep enough after the night shift	2 (28.6)	*"…dus als het me lukt om door te slapen dan vind ik het denk ik wel prettiger [om 1 keer te slapen], omdat het dan iets meer bij je ritme hoort"*
Activities were already planned	1 (14.3)	*"Dus als ik een afspraak zou hebben dan zou ik niet denken van nou ja dan verzet ik die afspraak. Dan zou ik slapen aan 1 stuk".*
When the split-sleep schedule is proven to be better		
Yes	1 (14.3)	*"Als het echt bewezen wordt, ja".*
No, does not care about health consequences, damage is already done	1 (14.3)	*"…het kwaad is toch al geschied…"*

Note. n = frequency.

3.3.5 Intervention improvements split-sleep group

Half of the participants liked the current split-sleep schedule and had no improvements (Table 14). One especially liked the sleep times since these are not restricted to the minute: *"Jullie hebben niet echt hele strikte regels of zo. Dus dat is wel fijn eigenlijk".* The first and main idea for improving the sleep schedule was personalization, thus adapt the split-sleep schedule to the individual shift worker. For example shorten the nap (so there is more time to clean up the kitchen after dinner), advance the nap (so there is more time to prepare for work), and finally a flexible implementation of the bedtimes, so recreational time can be optimally utilized.

> *"Nou ja misschien als ik het nu zelf zou toepassen... dat je dan wat flexibeler in de tijden bent... want ik heb nu eerst vijf uur geslapen en dan twee tot drie uur… maar dat je daar vrij in bent hoe je dat in kunt delen, [zodat] je wel die totale aantal uren hebt".*

Second, spread the information when the split-sleep schedule is proven to be effective was important advice given by the participants, as the split-sleep schedule is not something they experiment with on their own when they sleep fine during the day: *"Ja, zelf ga je dat niet zo zeer uitproberen. Als je daar geen nut voor hebt dan denk je ah nou ja ik zie wel wanneer ik slaap".*

Table 14

Improvements for the split-sleep schedule named by the split-sleep group (n = 7)

Improvements	Expressions	*n* (%)	Sample quote
None		4 (57.2)	*"Nee niet dat ik zo weet".*
Personalization	Shorten the (evening) nap	1 (14.3)	*"... dan zou je 's avonds die tijd moeten verkorten... Dus zeg maar 's ochtends 6 uur en 's avonds uur. Dan heb je rond etenstijd net wat meer tijd".*
	Advance the (evening) nap	1 (14.3)	*"het zou makkelijker zijn als je die tijd iets mag opschuiven. Ik vond het fijn om van 18.00 tot 20.00 uur te slapen… meestal [sliep ik] van 19.00 tot 21.00 uur, maar dan is het best wel krap [om op tijd klaar te zijn voor het werk]".*
	Flexible implementation of bed times	1 (14.3)	*"Nou ja misschien als ik het nu zelf zou toepassen… dat je dan wat flexibeler in tijden bent… want ik heb nu eerst vijf uur geslapen en dan twee tot drie uur… [maar] ik zou [van de vijf uur] nog een stukje afhalen en die voor de nachtdienst er weer aan plakken, [zodat] je dan wel die totale aantal uren hebt, maar dat je daar vrij in bent hoe je dat in kunt delen".*

(continued)

Improvements	Expressions	*n* (%)	Sample quote
	There is no one advise that suits all	1 (14.3)	*"… ik denk dat het heel persoonlijk is voor iedereen… ik denk dat één advies heel lastig is, omdat [het slapen rondom nachtdiensten] voor iedereen zo verschillend [is]".*
Spread the word		2 (28.6)	*"Bedoel ik zou het uit mezelf nooit gedaan hebben als ik niet hieraan mee had gedaan. Dan zou ik het nooit doen, dan zou ik gewoon aan 1 stuk blijven slapen terwijl ik nu weet hoe het is en ik ook wel voordelen van [er van] in zie".*

Note. n = frequency.

3.3.6 Expectations of consolidated group towards the split-sleep schedule

The expectations of the consolidated group regarding expected, attitudes, subjective norm, perceived behavioural control and intentions are summarized in Table 15.

Table 15

Expectations towards the split-sleep schedule in the consolidated group (n = 9)

Attitudes	Expressions	*n* (%)	Sample quote
Thoughts			
Negative	Difficult	2 (22.2)	*"…dat zou ik echt wel lastig vinden."*
	Unpleasant	2 (22.2)	*"Ik had het denk ik niet fijn gevonden."*
Neutral	Prepared for a trial	1 (11.1)	*"Ik had het denk ik niet zo heel erg gevonden om een keer iets anders te proberen".*
	Curious	1 (11.1)	*"Ja daar was ik eigenlijk wel heel benieuwd naar hoe dat zou zijn."*
No idea		3 (33.3)	*"…ik weet niet hoe het is als je er om 13.00 of 14.00 uur eruit moet… met slapen dat weet ik eigenlijk [ook] niet. Dat heb ik nog nooit zo gedaan, ik heb nooit in 2 delen geslapen eigenlijk".*
Advantages			
Enjoy more of the day	See day light	3 (33.3)	*"Het positieve eraan zou ik vinden dat je dan nog licht ziet, want daglicht dat zie je gewoon bijna niet".*
	Be more active during the day	2 (22.2)	*"Ik denk dat ik overdag gewoon veel productiever zou zijn…"*

(continued)

Attitudes	Expressions	*n* (%)	Sample quote
Extra sleep		1 (11.1)	"*Ja waarschijnlijk dus als je zo'n dag hebt dat je niet aan 1 stuk door kan slapen dat je dan inderdaad gewoon in tweeën splitst".*
Stay closer to normal rhythm		1 (11.1)	*"Ja kan me voorstellen dat je wel een iets beter ritme houdt dan nu gooi ik het gewoon 100% om".*
Feel positive effects during the night shift		1 (11.1)	*"…omdat ik wel denk dat je dan meer energie hebt 's nachts".*
No idea		2 (22.2)	*"… ik moet eerlijk zeggen dat ik dat eigenlijk niet weet".*
Disadvantages			
Social life		5 (55.6)	*"maar ik zou dan wel mijn … gewone dagelijkse activiteiten gaan missen. Je hebt al een anti-sociale baan… ik denk dat als je je slaap patroon… opsplitst dat je nog verder sociaal afzakt".*
Disadvantages			
Change daily schedule		3 (33.3)	*"Maar meer omdat je … daar toch veel meer rekening mee [moet] houden met je planning dan als ik nu gewoon in 1 keer door slaap…"*
Perceived discomfort with the split-sleep schedule	Hard to plan with eating	1 (11.1)	*"… wanneer moet je dan eten. Eet je dan voordat je weer gaat slapen 's avonds of eet je weer daarna…"*
	Hard to get out of bed	1 (11.1)	*"ik denk vooral dat het opstaan voor mij wel… lastig zou zijn".*
	Hard to fall asleep during the evening	2 (22.2)	*"… ik zou het inslapen weer moeilijk vinden… dan [ben] je over je slaap heen".*
Physical complaints		1 (11.1)	*"Maar mijn ervaring is ook, zoals vandaag, dat [als ik uit de nachtdienst kom] dan slaap ik tot 12 uur en dan ben ik gewoon echt misselijk".*
Perceived discomfort with the split-sleep schedule	Not feeling rested	1 (11.1)	*"Als ik dan wakker zou worden, dan zou ik me niet uitgerust voelen".*
	Needs a hour to wake up when sleeping during the evening	1 (11.1)	*"… ik merk ook vaak als ik 's avonds ga slapen dan moet ik ook echt nadat ik wakker ben een uur… even… bijkomen. En dan pas te gaan werken".*

(continued)

Attitudes	Expressions	*n* (%)	Sample quote
	The nights would be hard if you cannot sleep during the evening	1 (11.1)	*"… als je niet kunt slapen 's avonds dan heb je wel echt heel erg kort geslapen. Dan denk ik dat het moeilijk is om de nacht vol te houden".*
Physical complaints		1 (11.1)	*"Maar mijn ervaring is ook, zoals vandaag, dat [als ik uit de nachtdienst kom] dan slaap ik tot 12 uur en dan ben ik gewoon echt misselijk".*
Subjective norm			
Less pleasant	Social life	4 (44.4)	*"Ik denk dat het wel lastiger is, want je leeft dan vrij veel langs elkaar heen… en als ik dan overdag wakker ben en 's avonds slaap dan zie je elkaar gewoon heel weinig".*
	Would not like it	2 (22.2)	*"…ik denk niet dat hij er heel gelukkig van wordt".*
Neutral	Own responsibility	1 (11.1)	*"Die zou daar niet zoveel van vinden denk ik, dat moet ik zelf weten".*
Feasible (one series per month		1 (11.1)	*"Maar verder op zich is het 1 keer in de maand 3 tot 5 nachten dus op zich is dat ook wel te doen…"*
Easier in weekends		2 (22.2)	*"In het weekend… zijn hun natuurlijk ook gewoon vrij. Dus dan is het makkelijker denk ik".*
Subjective norm when split-sleep is proven to better			
Would argue for implementation		1 (11.1)	*ja tuurlijk [zou hij er dan voorstander van zijn, als het beter is] voor je gezondheid. Maar hij zegt wel van 'ik vind het niet leuk, ik vind het niet gezellig'".*
Will survive		3 (33.3)	*"Als het er echt uit zou komen dat dit beter werkt dan wanneer je in 1 keer slaapt dan zal [hij] het denk ik wel mee vallen voor die paar nachten per maand".*
Influence on implementation			
None		2 (22.2)	*"… ik vind het zelf gewoon belangrijk om zelf iets aan mijn dag te hebben en een beetje fit te zijn. [Tijdens nachtdiensten] heb ik toch wel het gevoel dat ik onder een steen leef".*

(continued)

Perceived behavioural control	Expressions	*n* (%)	Sample quote
Factors that make it easy			
Fall easy asleep		2 (22.2)	*"Niet moeilijk…gezien hoe snel ik altijd in slaap val".*
Factors that make it hard			
Having to change daily habits		2 (22.2)	*"Het is wel te doen, maar ik heb mijn vaste planning… dus dan is het meer lastig [om het slapen te] plannen".*
Getting out of bed		1 (11.1)	*"Nou is opstaan wel een beetje een dingetje voor mij".*
Factors that make the schedule easier			
Work less night shifts in a row to spread to social burden		1 (11.1)	*"… als ik dat zou doen, dan zou ik bijvoorbeeld maar 2 [nachtdiensten] doen…Dus dan heb je het een beetje verdeeld en je sociale leven kun je dan ook een beetje verdelen.*
No idea		2 (22.2)	*dat weet ik niet… dat zou ik eigenlijk niet weten.*
Plan activities during the day		1 (11.1)	*"je moet niet een heel passieve middag hebben. Ik denk dat je wel even iets te doen moet hebben, wil je 's avonds [moe genoeg zijn]… om te kunnen slapen".*
Intentions			
Yes	Open for a trial	2 (22.2)	*"Ja, misschien wel".*
	Heard positive stories	1 (11.1)	*"Ik zat toevallig met D. in de nacht, zij moet in twee keer slapen en is overdag wakker en haar viel het wel mee. Dus ik dacht 'oh het is uit te proberen een keer'… en wie weet vind ik het wel fijner".*
When the split-sleep schedule is proven to be better			
Trial	Only when proven to be effective	3 (33.3)	*"Dan zou ik het wel willen proberen. Ik zeg niet dat ik het volhoud, maar als ik echt aan mijn lijf voel dat het voor mij ook beter is dan denk ik wel dat ik dat wel zou willen".*
	When it fits the planning	1 (11.1)	*"Dan zou ik het proberen als het uitkomt. Kijk als ik niks heb dan zou ik het wel kunnen doen…"*

(continued)

Intentions	Expressions	*n* (%)	Sample quote
Definitely		1 (11.1)	*"zeker als ik merk dat ik slecht heb geslapen… dan is 's ochtends vroeg naar huis rijden gewoon kei gevaarlijk... dan ben ik echt wel eens bang in de auto hoor".*
Maybe		1 (11.1)	*"dat ligt er een beetje aan hoeveel nachten ik heb, als ik er vier heb dan heb ik dus ook echt vier dagen geen leven, haha. Dan zou ik het afwisselen, de ene dag gesplitst aan de andere dag dan misschien niet".*

Note. n = frequency.

In general half of the participants in the consolidated group viewed the split-sleep schedule rather negative than positive. However, some were open for a trial. Whereas others had no idea if they would like the schedule or if they could sleep, as they have never slept in two times before.

Advantages

The major expected advantage named was: enjoy more of the day (e.g., be more active during the day). Surprisingly, only one participant expected a positive effect during the night shift. However, another participant had no idea if the schedule would help her during the night shift (e.g.,*"Ik weet niet of ik er meer uitgerust van zou zijn"*). Finally, a minority had no idea what the advantages could be.

Disadvantages

Important expected barriers were: the influence on social life (e.g., *"Je hebt al een anti-sociale baan… ik denk dat als je je slaap patroon… opsplitst dat je nog verder sociaal afzakt"*) and change daily schedule and habits (e.g., *"[je] moet toch veel meer rekening moet houden met je planning dan als ik nu gewoon in 1 keer door slaapt"*). In addition participants thought they might experience discomfort when following the schedule (e.g., they thought it would be hard for them to get out of bed, hard to fall asleep during the evening or thought they would not feel rested after the first sleep opportunity).

Subjective norm

A majority of the participants thought the split-sleep schedule might be less pleasant for their direct environment. Less social was the most named expression: *"ik denk dat het wel lastiger is, want je leeft dan vrij veel langs elkaar heen … dan zie je elkaar gewoon heel weinig"*. Furthermore, others were more neutral and believed the decision of following the split-sleep schedule is their own or the schedule is feasible for one night shift series a month. When split-sleep is proven to be effective participants thought there direct environment will be more supportive towards the split-sleep

schedule. Finally, only two participants were directly asked, however none of the participants thought the opinion of their direct environment would withhold them from trying (e.g., *"Nee… ik vind het zelf gewoon belangrijk om zelf het meeste aan mijn dag te hebben en een beetje fit te zijn…"*).

Perceived behavioural control

With an average of 4.4 on a scale from 1 to 10 the participants expected that following the split-sleep schedule would be moderate difficult (Table 16). Participants expected that following the split-sleep schedule would be easier when they fall asleep easily. Some participants found it hard to give a score, since they had not really a clear idea *("… ik heb het nog niet geprobeerd. [Dit cijfer] is gewoon een gevoelskwestie dus daar kan ik niks aanhangen"*). Furthermore, important expected factors that would increase the difficulty were: having to change current planning/habits and expected difficulty with following the split-sleep schedule (e.g., hard to get out of bed). In addition, working fewer successive night shifts, whereby the influence on social life is less and plan activities during the day were expected factors that could make following the schedule easier:

> *"…dan zou ik bijvoorbeeld geen 4 nachtdiensten doen, maar … bijvoorbeeld maar 2 ... dan heb je het een beetje verdeeld en kun je sociale leven ook een beetje verdelen ... ik denk dat je wel even iets te doen moet hebben, wil je 's avonds die tijd goed te kunnen benutten om te slapen".*

Finally some participants had no idea.

Table 16

Frequencies and percentages of the self-rated score regarding the expected difficulty following the split-sleep schedule in the consolidated group

	Score (1 to 10) (missing 2)	Frequency *n* (%)
Perceived behavioural control	3	1 (20)
	3.5	2 (40)
	5	1 (20)
	4	1 (20)

Note. n = frequency; the score scale was between 1 and 10, where 1 is very easy and 10 extremely difficult. Only the named numbers are presented.

Intentions

Even though in general none of the participants said they would never try the schedule, there were graduations in enthusiasm. Three participants were open for a trial out of curiosity or because they heard positive stories. In addition, six participants would only try the split-sleep schedule when it is proven to be effective, when it suits their planning, when the night shift series is short or switch between consolidated and split-sleep depending on the amount of night shifts:

> *"dat ligt er een beetje aan hoeveel nachten ik heb, als ik er vier heb dan zou ik het afwisselen, de ene dag gesplitst aan de andere dag dan misschien niet, maar dan. Ja, dan zou eigenlijk zwaarder wegen dat je fitter bent in de nacht, want daar heb je zelf natuurlijk ook meer profijt van".*

4 Discussion

The current study took a new approach by using an innovative split-sleep schedule in order to explore the effectiveness of the split-sleep schedule in a real-life setting, in a sample of healthy nurses working night shifts. Secondly, we tried to gain insights into the nurses' experiences, attitudes, social norm, perceived behavioural control and intentions with the split-sleep schedule. In this chapter, the main findings are summarized, interpreted and reflected to existing literature. This discussion concludes by presenting the study's strengths and limitations, as well as recommendations for implementation and an overall conclusion. The current findings are preliminary and based on 18 out of 40 participants.

4.1 Main findings, reflection on literature and interpretation

Contrary to expectations the split-sleep schedule did not lead to more objective sleep, higher alertness or lower subjective sleepiness. However, the TST on the two nights after the night-shift series and lapses during the night shift showed a trend towards significance, thereby indicating that the split-sleep group slept more hours on the two nights after the night-shift series and was more alert during the night-shift series compared to the consolidated group.

As the current split-sleep schedule is innovative, there is no existing literature that compares split-sleep (with two daytime sleep opportunities) with consolidated daytime sleep. However, Jackson et al. (2014) conducted a laboratory study with three conditions (night-time sleep, daytime sleep and split-sleep) using a different sleep schedule than the one adopted here. The sleep opportunities were equally divided into two periods of five hours: one at the circadian nadir (3 a.m. to 8 a.m.) and one at the circadian peak (3 p.m. to 8 p.m.) and were compared with daytime sleep.

Only the non-significant trend for TST on two nights after the night-shift series is in line with the previous results of Jackson et al. (2014). However, the current research studied participants' experiences with the split-sleep schedule as well, which show mixed results. Some participants shifted more easily and quickly back to their normal rhythm, while others did not notice any differences and still found it difficult to shift back. This difference may be due to individual differences and/or environmental factors.

The non-significant trend for alertness is not in line with Jackson et al. (2014). However, it is in line with Short et al. (2016), who, comparing different split-sleep schedules, concluded that prior time awake influences alertness at the circadian nadir. In addition, the current study's data also fit the alertness prediction model of Åkerstedt and Folkard (1995). In the interviews, participants expressed feeling more alert during the night shift. Therefore, even though no significant differences were found with quantitative measures, it appears that the split-sleep schedule has a positive impact on alertness.

The other outcomes were not in line with the previous research of Jackson et al. (2014), for which various explanations can be considered, as explained below.

Environment of study

Previous research (e.g., Jackson et al., 2014) took place in a laboratory setting, whereas the current study took a new approach by conducting tests in a real-life setting. Therefore, external factors (e.g., ambient heat, noise, adherence to the sleep schedule or test-environment conditions) could not be controlled, which may explain why no significant differences were found. For example, during the interviews, the consolidated group expressed that heat and noise during the day disturbed their sleep. Therefore, our results have higher ecological validity compared to Jackson et al. (2014) and the current results are more likely to apply in other contexts.

In the interviews, participants in the split-sleep group expressed being generally positive towards the split-sleep schedule. They found it feasible and acceptable, especially those who fall asleep easily. Enjoying more of the day, feeling positive effects during the night shift and finding it easier to plan meals and to eat were frequently named advantages.

However, the data indicate that this split-sleep schedule did not always perfectly match with the private life of the participants in the split-sleep group. Firstly, its influence on social life was the most frequently named disadvantage, especially when they were active during the evening. This is in line with Takahashi (2003), who suggests that sleeping during the evening may be difficult for shift workers, due to social or family-related activities. Surprisingly, in contrast to the majority, a minority felt that it was easier for them to have a social life, as they were active during the afternoon. In addition, participants thought that their direct environment had more difficulty in coping with their shift work when they followed the split-sleep schedule, as they found themselves to be less sociable because they have to sleep during the evening. Furthermore, participants were more open towards a continuation of the split-sleep schedule when they had no activities planned during the evening. Therefore, shift workers should be advised to make (social) plans during the day.

Secondly, having to change daily structure and/or habits, being preoccupied with sleep and experiencing difficulty in following the sleep schedule were important disadvantages of the split-sleep schedule named by the split-sleep group. Therefore, developing a personal sleep schedule whereby shift workers need to adapt their daily schedule as minimally as possible may make implementation more probable. Furthermore, a certain degree of coaching may be beneficial as well, in order to decrease preoccupation and help shift workers in following the split-sleep schedule.

Differences in sleep schedules

Secondly, the difference between the split-sleep schedule of Jackson et al. (2014) and our sleep schedule may explain the different results regarding TST and alertness. Firstly, the total (TIB) in the study of Jackson et al. (2014) was ten hours compared to eight hours in the current study. Jackson et al. (2014) concluded that the daytime sleep condition had sufficient time to recover and therefore did not find any differences in alertness. Furthermore, the alertness test was taken at different times between split-sleep and the control condition. Secondly, Jackson et al. (2014) had one sleep opportunity during the circadian nadir (when sleep pressure is high) and the time between both sleep bouts was seven hours. In the current study, the time between both sleep bouts was five hours and both took place during the day, when the circadian promotes activity. Both may result in less sleep and more SOL (Åkerstedt & Folkard, 1996a; 1996b).

Timing sleep opportunities

Thirdly, the timing of the second sleep opportunity may also play a role. It is predicted that the SOL is double around the evening sleep, as alertness lies just below a peak and the prior time awake is half compared to morning sleep after a night shift (Åkerstedt, 1995). This may explain the differences in SOL between both sleep bouts. This is in line with Short et al. (2016), who found that participants fell asleep rather easily during the afternoon, but had difficulty in maintaining sleep in the early evening; whereas participants who tried to sleep from 9 p.m. onwards had more difficulty falling asleep, though maintained sleep rather easily. Therefore, it appears that sleeping during (the beginning) of the evening is difficult, which may explain this study's results. In implementing the split-sleep schedule, it is therefore recommended to personalize the split-sleep schedule to shift workers' SOL, which entails that the evening nap is extended when the SOL is large and the TST is consequently too short. However, taking the qualitative data into account, the extension should only be as long as the SOL, as the evening nap has also been criticized regarding its influence on shift workers' private lives.

Furthermore, the two dropouts in the split-sleep group reported that they could not fall asleep during the evening nap. Explanations for this were not feeling tired and/or being afraid of sleep inertia, which were the main reasons for dropping out. Being afraid of waking up being tired corresponds to the study of Fallis et al. (2011), who interviewed nurses about their attitudes towards napping on the night shift. It can therefore be concluded that the current split-sleep schedule may not be suitable for all shift workers, which is in line with the study of Bonnefond et al. (2001) and Purnell, Feyer and Herbison (2002). Even though both of these studies included a nap during the night, half of the participants reported having a general difficulty with falling asleep during the nap. After six to twelve months, it appears that the difficulty of falling asleep decreased for half of the participants who originally had difficulty with it. However, the other half continued to experience difficulty. Therefore, it

appears that for the majority of shift workers, experience with a split-sleep schedule leads to easier execution of the split-sleep schedule. Experience and the SOL therefore appear to be important factors for satisfaction and ease with the implementation of the split-sleep schedule. In conclusion, it appears that napping may be an effective countermeasure for the majority of shift workers. Further research is needed to examine for who this schedule is suited and for who it is not. The current data can be used to make a start in creating user profiles, or so-called personas (LeRouge, Ma, Sneha, & Tolle, 2013). Appendix D shows a beginning of the personas that may be created.

Study sample

Fourthly, in the current study, nurses who sleep well during night shifts were included. Participants were required to work at least two series of three night shifts during a maximum timeframe of two months. The study showed that nurses who have sleeping problems during night shifts (e.g., those who sleep only a few hours after a night shift) did not meet this inclusion criterion, which led to a sample of participants who sleep well during night shifts. Thus, with the current sample, there is little room for improvement. It may be speculated that the split-sleep schedule is more effective for shift workers who do not sleep well during a series of night shifts. Studies regarding this study population are needed.

Timing of measures during the night shift

Fifthly, during the interviews, participants expressed that the split-sleep schedule had a positive effect on their sleepiness during the night shift. This is in line with Jackson et al. (2014), who found a difference between both sleep conditions. The timing of subjective sleepiness and alertness may also be an explanation for not finding differences in the quantitative data. Firstly, even though participants were instructed to first fill in the subjective sleepiness score and take the alertness test afterwards, it is possible that they first took the alertness test and filled in the subjective sleepiness score afterwards. The alertness test may have made participants more tired. In addition, participants expressed in the interviews that they became more aware of their alertness or lack of it, which may have influenced the subjective sleepiness score.

4.1.1 The consolidated group

The consolidated group was interviewed as well, in order to create recommendations on how to promote the split-sleep schedule. They had generally negative thoughts (e.g., difficult and unpleasant) towards the split-sleep schedule, as they perceived difficulty with following the schedule or had no idea. In general, the perceived advantages and disadvantages of the consolidated group are in line with the experienced advantages and disadvantages of the split-sleep group. However, the

consolidated group did not mention possible differences during the night shift. These findings are in line with Bonnefond et al. (2001), who suggest that shift workers are not immediately convinced that split-sleep may be useful within their context and that, over time (six months), the satisfaction with taking naps increased. Therefore, potential split-sleepers should be informed about the effectiveness, advantages and disadvantages before deciding to follow the split-sleep schedule, as this makes implementation more probable. Finally, participants were more open to implementation when they heard positive stories from colleagues who were assigned to the split-sleep group. Therefore, a role model message should be used in promoting the split-sleep schedule.

4.1.2 Thoughts on the long-term influence of shift work for both sleep groups

It is striking that the current sample has very limited knowledge about the health risks of shift work. Only breast cancer was frequently named, as participants had read about it in the news and/or publications. The lack of knowledge may negatively influence the implementation or adherence, as participants may not find a reason to comply. In order to increase the implementation or adherence, increasing knowledge about the risks of working night shifts may be considered. However, the message should be tailored carefully, as it may have adverse effects according to the Extended Parallel Process Model (EPPM) of Witte and Allen (2000).

By using a dual-process approach, the EPPM predicts when and how an individual reacts to threatening messages. Firstly, the individual assesses the threat (how susceptible and severely they feel towards the threat). When the threat is viewed as sufficient, the person is more motivated to continue to the second appraisal: the efficacy. Therefore, informing shift workers about the health risks is needed, as perceiving the threat will not lead individuals to process the full message. Secondly, the efficacy of the recommend response (self-efficacy and response efficacy) is reviewed. When the recommended response is perceived as effective and the person's self-efficacy is perceived as high, the person will continue towards danger-control and performs the recommended behaviour. However, when the self-efficacy and response efficacy are reviewed as low, the person wishes to control the fear by denial or avoidance the treat. Therefore, the message should have a threat as well as an effective countermeasure that is perceived as easy to follow.

4.2 Strengths and limitations

The current study has three strengths. Firstly, it is the first to conduct such a test in a real-life setting, thereby lending the results a higher ecological validity and a higher applicability in different settings. Secondly, it tested an innovative split-sleep schedule as a countermeasure for sleep deprivation that can be implemented without drastic work-environmental changes, which makes its implementation easier. Thirdly, the current study used mixed methods (quantitative as well as qualitative methods) to

study different factors of the split-sleep schedule, thereby increasing the validity of the results, as the topic is studied from different perspectives and the weaknesses of specific approaches are minimised. By using mixed methods, the results presented here are more reliable and valid.

Next to the strengths, the study has some limitations as well. Firstly, there are three limitations regarding the study sample. First of all, as the study sample is small, the current results are preliminary. This study may not have sufficient power to detect differences between groups and should therefore be continued. Secondly, the study sample may have suffered from a sample bias. The participants were sampled through convenience sampling, thereby making it possible that non-nappers did not sign up for the study (Ficca, et al., 2010). This was confirmed in the interviews, in which participants explained that some of their colleagues did not sign up because they did not wish to be assigned to the split-sleep group. Indicating that the current sample may only consist of nurses who are generally open minded or more positive towards the split-sleep schedule, which could made our qualitative data a too positive representation of the entire population. In addition, it appears that the some shift workers needs some convincing in order to try the split-sleep schedule. Therefore spreading the information adequate is extremely important. Thirdly, the current sample consisted of nurses who generally sleep well during a series of night shifts and who therefore do not fit with the association found in the literature between shift work and short day sleep. Nurses who have sleeping problems during night shifts worked fewer night shifts and were therefore not eligible for inclusion in this study. Thus, the current sample had little margin for improvement with the split-sleep schedule.

Secondly, participants expressed in the interviews that they did not always have time for the reaction-time task or to fill in the subjective sleepiness score during the night shift, which led to missing data. In addition, it was frequently expressed that the reaction-time task was boring and consumed quite some time. Nurses explained that they frequently had to stop the test or had no time to complete the task, especially in the middle of the night shift, which resulted in frustration with the test and less motivation to restart it. Further field studies could consider to use a reaction-time task of only five minutes. Loh, Lamond, Dorrian, Roach and Dawson (2004) found that five minutes reaction-time tasks may be an acceptable alternative in field settings in which time constraints are important. Both the five and the ten-minute tasks showed significant decline in reaction time over a night of sleep loss. However, it is predicted that a five-minute task may not be sufficiently sensitive to detect a decline in the number of lapses.

Thirdly, subjective sleepiness was also measured during the day (these results are not included in the current thesis). At 4 p.m. and 6 p.m., the Actiwatch sounded an alarm requesting the KSS score. During the interviews, some participants in the consolidated group mentioned that they frequently woke up from the alarm. Thus, the control group may have slept longer without this alarm, thereby influencing the TST of the control group negative manner.

Lastly, during the interviews, a pleasant conversation was a main priority, which led to missing data. Different questions were occasionally missed in different interviews, which especially affected the subjective norm. The conclusion regarding the subjective norm must therefore be drawn and interpreted carefully.

4.3 Implementation recommendations

- By using an application and wearable device, the split-sleep schedule should be personalized to the SOL and wishes/personal life of the shift worker, as it is not time consuming. Firstly, a baseline series should be measured in which current sleep during night shifts is examined. Subsequently, the shift workers experience the current split-sleep schedule during a trial of one or two series of night shifts, after that the application offers personal advice regarding TST, SOL and whether the split-sleep schedule suits the person (regarding the personas and based on baseline data). Subsequently, the shift worker fills in his/her preferable sleep times in order to create a suitable split-sleep schedule. In addition, the application should give feedback on the preferable sleep times regarding feasibility and health. Finally, the personal split-sleep schedule is created.
- In order to help shift workers to adhere to the split-sleep schedule, the application should have certain persuasive features. Firstly, an alarm feature, role model and coaching programme may help the shift worker. The coaching programme should advise shift workers to plan social activities during the day (when possible). Finally, the app should be linked to a weather application, as sleeping during the day is more difficult when it is warm. The application can recommend the split-sleep schedule.
- The current thesis consists of preliminary results. The interviews showed that good sleepers during night shifts do not attempt to adopt a split-sleep schedule on their own initiative. Participants wanted to be informed. It therefore appears interesting to add a question in the study about how participants wish to be informed about the split-sleep schedule and/or its possible application. This brings further insights into implementation strategies.
- When the split-sleep schedule is proven to be beneficial, the information about the split-sleep schedule should be spread to as many shift workers as possible and be tailored for shift workers using the EPPM. The increased risk of occupational accidents and injuries, and diseases should form the threat and the split-sleep schedule forms the effective countermeasure. By using the currently named advantages and disadvantages, shift workers can evaluate their efficacy and the study should help to convince shift workers split-sleep is an effective countermeasure schedule towards accidents and health.

4.3 Future research

The current study shows that the split-sleep schedule may be effective for bad sleepers and for partially good sleepers during the night shift. The sample consisted of good sleepers, though it would be interesting to examine the effects of a split-sleep schedule for shift workers who have sleeping problems during their night-shift series. In addition, it is unclear for who the split-sleep schedule is effective and for who it is not. Participants in the split-sleep group were more positive towards the split-sleep schedule when they fell asleep easily. In addition, the dropouts could not sleep during the evening. It is possible that flexibility in sleep habits is a predicting factor for split-sleep, though further research is needed on flexibility and other potential factors in order to conclude for who it works and for who it does not. These data can be used to further personalize the split-sleep schedule. In addition, it is clear beforehand when the split-sleep schedule is not effective and can be discouraged.

In addition, further research needs to be pursued with shift workers who are informed beforehand about the possibility of a longer SOL, and about the advantages and disadvantages of the split-sleep schedule. In addition, future research should study the effects of such personalised split-sleep schedules.

Furthermore, the current thesis averaged the results of the three assessment points of alertness and subjective sleepiness during the night shift into one score. However, due to the circadian nadir that takes place between 3 a.m. and 6 a.m., it is interesting to consider which the effects the split-sleep schedule has during the night shift. In addition, in order to gain more knowledge about the effectiveness of the split-sleep schedule, it is interesting to examine its effects between shifts within a series and between the first and second night-shift series.

Finally, only two studies are available about shift workers' experiences with a split-sleep schedule (both regarding napping during the night shift). Without more data, it is challenging to implement a split-sleep schedule. Further research should not only focus on the effectiveness of a split-sleep schedule, but on the experiences as well. Further research on experiences may enhance or improve the effects of the split-sleep schedule, which makes implementation more likely and provides more benefits to the users.

4.4 Overall conclusion

The current study adopted a mixed-method approach in order to evaluate the effectiveness of an innovative split-sleep schedule in a real-life setting and to explore participants' experiences with the split-sleep schedule. It suggest that the split-sleep schedule appears to be generally promising for shift workers and that it is also beneficial shortly after a night-shift series. The split-sleep schedule may be an effective strategy for a proportion of nurses who work night shifts. However, the data indicate that it may not be effective for everyone: Shift workers who cannot sleep during the evening may sleep

better with consolidated day sleep. Important implementation strategies are the personalization of the split-sleep schedule and informing shift workers about split-sleep. However, before it is possible to draw definitive conclusions, the results for the entire study population must be awaited.

References

Åkerstedt, T. (1995). Work hours and sleepiness. *Neurophysiol Clin, 25,* 367-375.

Åkerstedt, T. (1998). Shift work and disturbed sleep/wakefulness. Sleep Medicine Reviews, 2(2), 117-128. doi: http://dx.doi.org/10.1016/S1087-0792(98)90004-1

Åkerstedt,T., Anund, A., Axelsson, J., & Kecklund, G. (2014). Subjective sleepiness is a sensitive indicator of insufficient sleep and impaired waking function. *J Sleep Res., 23,* 242-254. doi: 10.1111/jsr.12158

Åkerstedt, T. & Folkard, S. (1995). Validation of the S and C components of the Three-Process Model of alertness regulation. *Sleep, 18*(1), 1-6.

Åkerstedt, T. & Folkard, S. (1996a). Predicting duration of sleep from the three process model of regulation of alertness. *Occupational and Environmental Medicine, 53,* 136-141.

Åkerstedt, T. & Folkard, S. (1996b). Predicting sleep latency from the three-process model of alertness regulation. *Psychophysiology, 33,* 385-389.

Åkerstedt, T. & Gillberg, M. (1990). Subjective and objective sleepiness in the active individual. *Int J Neurosci, 52,* 29-37.

Åkerstedt, T., & Wright Jr., K. P. (2009). Sleep loss and fatigue in shift work and shift work disorder. *Sleep Med Clin, 4*(2), 257-271. doi: 10.1016/j.jsmc.2009.03.001

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes, 50,* 179-211.

Ajzen, I. (2011). The theory of planned behaviour: reactions and reflections. *Psychology & Health, 26*(9), 1113-1127. doi: 10.1080/08870446.2011.613995

Basner, M. & Dinges, D. (2011). Maximizing sensitivity of the psychomotor vigilance test (PVT) to sleep loss. *SLEEP, 34*(5), 581-591.

Bass, J. (2012). Circadian topology of metabolism. *Nature, 491,* 348-356. doi: 10.1038/nature11704

Belenky, G., Wu, L.J., & Jackson, M. L. (2011). Occupational sleep medicine: Practice and promise. *Progress in Brain Research, 190,* 189-203. doi: 10.1016/B978-0-444-53817-8.00012-8

Bilic, B. (2005). Theory of planned behaviour and health behaviours: critical analysis of methodological and theoretical issues. *Hellenic Journal of Psychology, 2*, 243-259.

Bøggild, H. & Knutsson, A. (1999). Shift work, risk factors and cardiovascular disease. *Scand J Work Environ Health, 25*(2), 85-99. doi: 10.5271/sjweh.410

Bonham, M. P., Bonnell, E. K., Huggins, C. E. (2016). Energy intake of shift workers compared to fixed day workers: A systematic review and meta-analysis. *Chronobiology International, 33*(8), 1086-1100. doi: 10.1080/07420528.2016.1192188

Bonnefond, A., Muzet, A., Winter-Dill, A. S., Bailloeuil C., Bitouze, F., & Bonneau A. (2001). Innovative working schedule: introducing one short nap during the night shift. *Ergonomics, 44*(10), 937-945. doi: 10.1080 /0014013011006113 8

Bonnefond, A., Tassi, P., Roge, J., & Muzet, A. (2004). A critical review of techniques aiming at enhancing and sustaining worker's alertness during the night shift. *Industrial Health, 42,* 1-14.

Bonnet, M. H. (1991). The effect of varying prophylactic naps on performance, alertness and mood throughout a 52- hour continuous operation. *Sleep, 14*(4), 307-315.

Brennan, M. L., Wright N., Wapenaar, W., Jarratt, S., Hobson-West, P., Richens, I. F, … Connor, H. M. O. (2016). Exploring attitudes and beliefs towards implementing cattle disease prevention and control measures: A qualitative study with dairy farmers in Great Britain. *Animals, 6*(61), 1-15. doi: 10.3390/ani6100061

Brooks, A. & Lack, L. (2006). A brief afternoon nap following nocturnal sleep restriction: which nap duration is most recuperative? *SLEEP, 26*(6), 831-840.

Buysse, D. J., Reynolds C. F. III, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1988). The Pittsburgh sleep Quality Index: A New Instrument for Psychiatric Practice and Research. *Psychiatry Research, 28,* 193-213.

Cain, S. W., Filtness, A. J., Phillips, C. L., & Anderson, C. (2015). Enhanced preference for high-fat foods following a simulated night shift. *Scand J Work Environ Health, 41*(3), 288-293. doi: 10.5271/sjweh.3486

Centraal Bureau voor Statistiek (2014). Beroepsbevolking; regeling werktijden. Retrieved on June 8th 2016 from:http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=71959 ned&D1=1-7&D2=0&D3=a&D4=a&VW=T

Chatzitheochari, S., & Arber, S. (2009). Lack of sleep, work and the long hours culture: evidence from the UK Time Use Survey. *Work, employment and society, 23*(1), 30-48. doi: 10.1177/0950017008099776

Cipolla-Neto, J., Amaral, F. G., Afeche, S. C., Tan, D. X., & Reiter, R. J. (2014). Melatonin, energy metabolism, and obesity: a review. *J. Pineal Res., 56,* 371-381. doi: 10.1111/jpi.12137

Costa, G., Haus, E., Stevens, R. (2010). Shift work and cancer – considerations on rationale, mechanisms, and epidemiology. *Scand J Work Environ Health, 36*(2), 163-179. doi: 10.5271/sjweh.2899

Darker, C., D., D. (2007). Applying the theory of planned behaviour to walking: development and evaluation of measures and an intervention. Retrieved on 26-10-2016 from: http://etheses.bham.ac.uk/1433/1/Darker08PhD_A1a.pdf

De Castro, A. B., Fujishiro K., Rue, T., Tagalog, E. A., Samaco-Paquiz, L. P. G., & Gee, G. C. (2010). Associations between work schedule characteristics and occupational injury and illness. *Int Nurs Rev., 57*(2), 188-194. doi: 10.1111/j.1466-7657.2009.00793.x.

Dembe, A. E., Erickson, J. B., Delbos, R. G., & Banks, S. M. (2006). Nonstandard shift schedules and the risk of job-related injuries. *Scand J Work Environ Health, 32*(3), 323-340.

Endinger, J. D., Means, M. K., Stechuchak, K. M., & Olsen, M. K. (2004). A pilot study of inexpensive sleep-assessment devices. *Behavioral sleep medicine, 2*(1), 41-49. doi: 10.1207/s15402010bsm0201_4

Edwards, M.P., McMillan, D. E., & Fallis, W. M. (2013). Napping during breaks on night shift: Critical care nurse managers' perceptions. *Dynamics, 24*(4), 30-35.

Fallis, W. M., McMillan, D. E., & Edwards, M. P. (2011). Napping during night shift: practices, preferences, and perceptions of critical care and emergency department nurses. *Critical care nurse, 31*(2), e1-e11. doi: 10.4037/ccn2011710

Ficca, G., Axelsson, J., Mollicone, D. J., Muto, V., & Vitiello, M. V. (2010). Naps, cognition and performance. *Sleep Medicine Reviews, 14,* 249-258. doi: 10.1016/j.smrv.2009.09.005

Fields, A. (2009). *Discovering statistics using SPSS.* London: Sage.

Finn, P. (1981). The effects of shift work on the lives of employees. *MONTHLY LABOR REVIEW,* 31-35.

Frost, P., Kolstad, H.A., & Bonde, J. P. (2009). Shift work and the risk of ischemic heart disease – a systematic review of the epidemiologic evidence. *Scand J Work Environ Health, 35*(3), 163-179. doi: 10.5271/sjweh.1319

Folkard, S., Lombardi, D. A., & Tucker, P. T. (2005). Shiftwork: safety, sleepiness and sleep. *Ind Health, 43*(1), 20-23.

Folkard, S., & Tucker, P. (2003). IN-DEPTH REVIEW: SHIFT WORK
Shift work, safety and productivity. *Occupational Medicine, 53,* 95-101. doi: 10.1093/occmed/kqg047

Garbarino, S., Mascialino, B., Penco, M. A., Squarcia, S., De Carli, F., Nobili, L., … Ferrillo, F. (2004). Professional shift-work drivers who adopt prophylactic naps can reduce the risk of car accidents during night work. *SLEEP, 27*(7), 1295-1302.

Gratton, L., Povey, R., & Clark-Carter, D. (2007). Promoting children's fruit and vegetable consumption: interventions using the theory of planned behaviour as a framework. *Br J Health Psychol, 12*(4), 639-650. doi: 10.1348/135910706X171504

Gleitman, H., Gross, J., & Reisber, D. (2011). Psychology. Canada: Norton & Company, Inc.

Gonnissen, H. K. J., Muzay, C., Rutters, F., Martens, E. A. P., Adam, T. C., & Westerterp-Plantenga, M. S. (2013). Sleep architecture when sleeping at an unusual circadian time and associations with insulin sensitivity. *PLoS ONE, 8*(8), e72877. doi: 10.1371/journal.pone.0072877

Han, Y., Yuan, Y., Zhang, L., & Fu Y. Sleep disorder status of nurses in general hospitals and its influencing factors. *Psychiatria Danubina, 28*(2),176-183.

Härmä, M., Sallinen, M., Ranta, R., Mutanan, P., & Müller, K. (2002). The effect of an irregular shift system on sleepiness at work in train drivers and railway traffic controllers. *J Sleep Res, 11*(2), 141-151.

Härmä, M. (2006). Workhours in relation to work stress, recovery and health. *Sand J Work Environ Health, 32*(6), 502-514. doi: 10.5271/sjweh.1055

Haus, E. L. & Smolensky, M. H. (2013). Shift work and cancer risk: potential mechanistic roles of circadian disruption, light at night, and sleep deprivation. *Sleep Medicine Reviews, 17,* 273-284. doi: http://dx.doi.org/10.1016/j.smrv.2012.08.003

Hilditch, C.J., Centofanti, S. A., Dorrian, J., & Banks, S. (2016). A 30-minute, but not a 10-minute nighttime nap is associated with sleep inertia. *Sleep, 39*(3), 675-685. doi: 10.5665/sleep.5550

Hofer-Tinguely, G., Achermann, P., Landolt, H. P., Regel, S. J., Re'tey, J. V., Dqrr, R., Borbe'ly, A. A., & Gottseling, J. M. (2005). Sleep inertia: performance changes after sleep, rest and active waking. *Cognitive Brain Research, 22,* 323-331. doi: 10.1016/j.cogbrainres.2004.09.013

Itani, O., Jike, M., Watanabe, N., & Kaneita, Y. (2016). Short sleep duration and health outcomes: a systematic review, meta-analysis and meta-regression. *Sleep Medicine.* doi: http://dx.doi.org/10.1016/j.sleep.2016.08.006

Jackson, M. L., Banks, S., & Belenky, G. (2014). Investigation of the effectiveness of a split sleep schedule in sustaining sleep and maintaining performance. *Chronobiology International: The Journal of Biological and Medical Rhythm Research, 31*(10), 1218-1230. doi: 10.3109/07420528.2014.957305

Jackson, M. L., Croft, R. J., & Kennedy, G. A. (2013). Cognitive components of simulated driving performance: Sleep loss effects and predictors. *Accident Analysis and Prevention, 50,* 438-444. doi: http://dx.doi.org/10.1016/j.aap.2012.05.020

Jahn, R. G. & Dunne, B. J. (1997). Science of the Subjective. Essay in: *Journal of Scientific Exploration, 11*(2), 201-224.

Jongen, S., Perrier, J., Vuurman, E. F, Ramaekers, J. G., & Vermeeren, A. (2015). Sensitivity and Validity of Psychometric Tests for Assessing Driving Impairment: Effects of Sleep Deprivation. *PLoS ONE*, *10*(2), e0117045. doi:10.1371/journal.pone.0117045

Kaida, K., Takahasi, M., Åkerstedt, T. Nakata, A., Otasuka, Y., Haratani, T., & Fukasawa, K. (2006). Validation of the Karolinska sleepiness scale against performance and EEG variables. *Clinical Neurophysiology, 117,* 1574-1581. doi: 10.1016/j.clinph.2006.03.011

Kecklund, G. & Axelsson, J. (2016). Health consequences of shift work and insufficient sleep. *BMJ, 355,* j5210. doi: 10.1136/bmj.i5210

Khalsa, S. B. S., Jewett, M. E., Cajochen, C., & Czeisler, C. A. (2003). A phase response curve to single bright light pulses in human subjects. *J. Physiol, 549*(3), 945-952. doi: 10.1113/jphysiol.2003.040477

Khanijow, V., Praksash, P., Emsellem, H. A., Borum, M. L., and Doman, D. B. (2015). Sleep Dysfunction and Gastrointestinal Diseases. *Gastroenterology & Hepatology, 11*(12), 817-825.

Knowlden, A. P., Sharma, M., & Bernard, A. L. (2012). A theory of planned behavior research model of predicting sleep intentions and behaviors of undergraduate college students. *J Primary Prevent, 33,* 19-31. doi: 10.1007/s10935-012-0263-2

Knutsson, A. (2003). IN-DEPTH REVIEW: SHIFT WORK Health disorders of shift workers. *Occupational Medicine, 53,* 103-108. doi: 10.1093/occmed/kqg048

Knutson K. L. & Van Cauter, E. (2008). Associations between sleep loss and increased risk of obesity and diabetes. *ANN N Y Acad Sci, 1129,* 287-304. doi: 10.1196/annals.1417.033

Kooyman, J. (2015). *Is Nederland geschikt voor een 24-uurseconomie?* Retrieved on 17-10-2016 from https://www.nrc.nl/nieuws/2015/12/14/woon-jij-straks-in-de-24-uursstad-a1494277

Kosmadopoulos, A., Sargent, C., Darwent, D., Zhou, X., Dawson, D., & Roach, G. D. (2004). The effects of a split sleep-wake schedule on neurobehavioural performance and predictions of performance under conditions of forced desynchrony. *Chronobiology International, 31*(10), 1209-1217. doi: 10.3109/07420528.2014.957763

Kushida, C. A., Chang, A., Gadkary, C., Guilleminault, C., Carrillo, O., & Dement, W. C. (2001). Comparison of actigraphic, polysomnographic, and subjective assessment of sleep parameters in sleep-disordered patients. *Sleep medicine, 2,* 389-396.

Lao, H. C. F., Tao, V. Y. K., Wu, A. M. S. (2016). Theory of planned behaviour and healthy sleep of college students. *Australian Journal of Psychology, 68,* 20-28. doi: 10.1111/ajpy.12094

LeRouge, C., Ma, J., Sneha, S., & Tolle, K. (2013). User profiles and personas in the design and development of consumer health technologies. *Int J Med Inform, 82*(11), e251-e268. doi: 10.1016/j.ijmedinf.2011.03.006

Loh, S., Lamond, N., Dorrian, J., Roach, G., & Dawson D. (2004) The validity of psychomotor vigilance tasks of less than 10-minute duration. *Behavior Research Methods, Instruments, & Computers, 36*(2), 339-346.

Mantua, J., Gravel, N., & Spencer, R. M. C. (2016). Reliability of sleep measures from four personal health monitoring devices compared to research-based actigraphy and polysomnography. *Sensors, 16,* 1-11. doi: 10.3390/s16050646

McDonald, J., Potyk, D., Fischer, D., Parmenter, B., Lillis, T., Bowen, A., Grant, D., Lamp, A., & Belenky, G. (2013). Napping on the Night Shift: A study of sleep, performance, and learning in physicians-in-training*. Journal of Graduate Medical Education,* 634-638. doi: http://dx.doi.org/10.4300/JGME-D-12-00324.1

Mollicone, D. J., Van Dongen, H. P. A., Rogers, N. L., & Dinges, D. F. (2008). Response surface mapping of neurobehavioral performance: Testing the feasibility of split sleep schedules for space operations. *Acta Astronautica, 63,* 833-840. doi:10.1016/j.actaastro.2007.12.005

Morris, C. J., Aeschback, D., & Scheer, F. A. J. L. (2012). Circadian system, sleep and endocrinology. *Mol Cell Endocrinol, 349*(1), 91-104. doi: 10.1016/j.mce.2011.09.003.

Muzet, A., Nicolas, A., Tassi P., Dewasmes, G., & Bonneau, A. (1995). The implementation of napping in industry and the problem of sleep inertia. *Journal of sleep research, 4*(2), 67-69. doi: 10.1111/j.1365-2869.1995.tb00230.x

Nea, F. M., Kearney, J., Livingstone, M. B., Pourshahidi, L. K., & Corish, C. A. (2015). Dietary and lifestyle habits and the associated health risks in shift workers. *Nutr Res Rev, 28*(2), 143-166. doi: 10.1017/S095442241500013X

Ohayon, M. M., Smolensky, M. H., & Roth, T. (2010). Consequences of shift-working on sleep duration, sleepiness, and sleep attacks. *Chronobiol Int, 27*(3)*,* 575-89. doi: 10.3109/07420521003749956.

Pan, A., Schernhammer, E. S., Sun, Q., & Hu, F. B. (2011). Rotating Night Shift Work and Risk of Type 2 Diabetes: Two Prospective Cohort Studies in Women. *PLoS med, 8*(12), e1001141. doi: 10.1371/journal.pmed.1001141

Pisarski, A., Bohle, P., & Callan, V. J. (1998). Effects of coping strategies, social support and work-nonwork conflict on shift worker's health. *Scand J Work Envrion Health, 24*(3), 141-145.

Philips Respironics (n.d.). Actiwatch spectrum pro. Retrieved on 20, September, 2016 from http://www.actigraphy.com/solutions/actiwatch/actiwatch-pro-specifications.html

Proper, K., I., Langenberg, D., van de, Rodenburg, W., Vermeulen, R. C. H., Beek, A. J., van der, Steeg, H. van, & Kerkhof, L. W. M., van (2016). The relationship between shift work and metabolic risk factors. *American journal of preventive medicine*, 50(5), e147-e157. doi: http://dx.doi.org/10.1016/j.amepre.2015.11.013

Purnell, M. T., Feyer, A. M., & Herbison, G. P. (2002). The impact of a nap opportunity during the night shift on the performance and alertness of 12-h shift workers. *J. Sleep Res, 11,* 219-227.

Rajaratnam, S.M.W., & Arendt, J. (2001). Health in a 24-h society. *THE LANCET, 358,* 999-1005.

Roach, G. D., Zhou, X., Darwent, S., Kosmadopoulos, A., Dawson, D., & Sargent, C. (2015). Are two halves better than one whole? A comparison of the amount and quality of sleep obtained by healthy adult males living on split and consolidated sleep-wake schedules. *Accid. Anal, Prev.* doi: http://dx.doi.org/10.1016/j.aap.2015.10.012

Ruggiero, J. S. & Redeker, N., S. (2014). Effects of napping on sleepiness and sleep-related performance deficits in night-shift workers: a systematic review. *Biol Res Nurs, 16*(2), 134-142. doi: 10.1177/1099800413476571

Schmidt, M., Johannesdottir, S. A., Lemeshow, S., Lash, T. L., Ulrichsen, S. P., Bøther, H. E., & Sørenson H. T. (2013). Obesity in young men, and individual and combined risks of type 2 diabetes, cardiovascular morbidity and death before 55 years of age: a Danish 33-year follow-up study. *BMJ Open, 3,* e002698. doi: 10.1136/bmjopen-2013-002698

Segawa, K., Nakazawa, S., Tsukamoto, Y., (1987) in Khanijow, V., Praksash, P., Emsellem, H. A., Borum, M. L., & Doman, D. B. (2015). Sleep Dysfunction and Gastrointestinal Diseases. *Gastroenterology & Hepatology, 11*(12), 817-825.

Short, M. A., Centofanti, S., Hilditch, C., Banks, S., Lushington, K., Dorrian, J. (2016). The effect of split sleep schedules (6h-on/6h-off) on neurobehavioural performance, sleep and sleepiness. *Applied Ergonomics, 54,* 72-82. doi: http://dx.doi.org/10.1016/j.apergo.2015.12.004

Sniehotta, F. F., Presseau, J., & Araújo-Soares, V. (2014). Time to retire the theory of planned behavior. *Health psychology review, 8*(1), 1-7. doi: 10.1080/17437199.2013.869710

Spiegel, K., Leproult, R., & Van Cauter, E. (1999). Impact of sleep debt on metabolic and endocrine function. *THE LANCET, 354,* 1435-1439.

Storch, K-F., Lipant, O., Leykin, I., Viswanathan, N., Davis, F. C., Wong, W. H., & Weitz, C. J. (2002). Extensive and divergent circadian gene expression in liver and heart. *Nature, 417,* 78-83. doi: 10.1038/nature744.

Takahashi, M. (2003). The role of prescribed napping in sleep medicine. *Sleep Medicine Reviews, 7*(3), 227-235. doi: 10.1053/smrv.2002.0241

Takahashi, M., Arito, H., & Fukuda, H. (1999). Nurses' workload associated with 16-h night shift. II: Effects of a nap taken during the shifts. *Psychiatry and Clinical Neurosciences, 53,* 223-225.

Takeyama, H., Kubo, T., & Itani, T. (2005). The nighttime nap strategies for improving night shift work in workplace. *Industrial Health, 43,* 24-29.

Tassi, P. & Muzet, A. (2000). Sleep inertia. *Sleep Medicine Reviews, 4*(4), 341-353. doi: 10.1053/smrv.2000.0098

Tong, A., Sainsbury, P., & Craig J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32 item checklist for interviews and focus groups. *International journal for Quality in Health care, 19*(6), 349-357. doi: 10.1093/intqhc/mzm042

Tremaine, R., Dorrian, J., Lack, L., Lovato, N., Ferguson, S., Zhou, X., & Roach, G. (2010). The relationship between subjective and objective sleepiness and performance during a simulated night- shift with a nap countermeasure. *Applied Ergonomics, 42,* 52e-61e. doi: 10.1016/j.apergo.2010.04.005

Vetter, C., Devore, E. E., Wegrzyn, L., R., Massa, J., Speizer, F. E., Kawachi, I,… Schernhammer, E. S. (2016). Association between rotating night shiftwork and risk of coronary heart disease among woman. *JAMA, 316*(16), 1726-1734. doi: 10.1001/jama.2016.4454

Vitra, J.J., Heikkilä, K., Perola, M., Koskenvuo, M., Räihä, I., Rinne, J.O., & Kaprio, J. (2013). Midlife Sleep Characteristics Associated with Late Life Cognitive Function. *SLEEP, 36*(10), 1533-1541. doi: http://dx.doi.org/10.5665/sleep.3052

Wagstaff, A. S. & Sigstad Lie, J-A. (2011). Shift and night work and long working hours – a systematic review of safety implications. *Scand J Work Environ Health, 37*(3), 173-185. doi: 10.5271/sjweh.3146

Wang, F., Yeung, K. L., Chan, W. C., Kwok, C. C., Leung, S. L., Wu, C,… Tse, L. A. (2013). A meta-analysis on dose response relationship between night shift work and the risk of breast cancer. *Ann Oncol, 24*(11), 2724-2732. doi: 10.1093/annonc/mdt283

White, L. & Keith, B. (1990). The effect of shift work in the quality and stability of martial relations. *National Council on Family Relations, 52*(2), 453-462. doi: 10.2307/353039

Wilkinson, R. T. & Houghton, D. (1982). Field test of arousal: a portable reaction timer with data storage. *Human factors, 24*(4), 487-493.

Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education & Behavior*, *27*, 591-615.

Appendix A

Interview protocol

EXIT INTERVIEW

Duur van het interview: ongeveer 30 minuten.

Introductie (5 minuten)

- Bedankt voor uw deelname.
- Ik ben Marleen en doe mijn afstudeeronderzoek bij Philips Research. Voor dit onderzoek interview ik deelnemers na afloop van de studie om meer te weten te komen over de ervaringen met het deelnemen aan dit onderzoek, over het split-slapen, maar ook over gezondheid in het algemeen, uw slaappatroon en mening over nachtdiensten zullen aanbod komen.
- Is het oké als dit gesprek opgenomen wordt? (we gebruiken dit uiteraard alleen intern).
- We vragen naar uw mening, maar ook uw gedachten en gevoelens zijn hierbij erg belangrijk. Er zijn geen goede of foute antwoorden.
- Als u een pauze nodig heeft of ergens niet over wilt praten geef dat dan alstublieft aan dat is helemaal prima.
- Alle informatie en antwoorden die u in dit interview geeft zullen geanonimiseerd worden verwerkt.

1. Hoe is het gegaan de afgelopen periode?

Split-slaap groep

2. Wat vond u van het verkregen slaapadvies?
3. Hoe was het voor u om het slaapadvies op te volgen?
4. Wat zijn de positieve kanten aan het slaap advies?
5. Wat zijn de negatieve kanten van het slaap advies?
6. Welk cijfer zou u geven voor de moeilijkheid van het opvolgen? (1 t/m 10) en wat maakt dit moeilijk?
7. Hoe zou dit makkelijker worden?
8. Hoe was het voor je directe omgeving het slaap advies?
9. Denkt u dat u dit split-slaap schema zal blijven opvolgen? Waarom wel/waarom niet? (wat houdt u tegen?)
    a. Stel we vinden goed resultaten zou u het dan opvolgen?
10. Hoe zou uw directe omgeving het vinden als u door zou gaan met dit slaap advies?
11. Hoe belangrijk denkt u dat uw directe omgeving het vindt om door te gaan met dit slaap advies?

Controle groep

2. Stel we hadden u gevraagd om in 2 keer te slapen, wat had u daar van gevonden?
3. Wat zou u positieve en negatieve kanten vinden van in 2 keer slapen ten opzicht van 1 keer slapen?
4. Stel we vinden dat in 2 keer slapen beter is, zou je het dan proberen? (waarom wel/waarom niet?)
5. Hoe zou je omgeving dat vinden? Hoe sterk beïnvloedt dit uw keuze om het wel of niet te gaan doen?
6. Hoe moeilijk denkt u het te vinden om uit te voeren?
7. Wat zou dit vergemakkelijken?

Nachtdiensten en slaap (5 minuten)

1. Wat zijn de positieve kanten van nachtdiensten werken?
2. Wat zijn de negatieve kanten van nachtdiensten werken?
3. Hoe beïnvloedt dit uw dagelijkse leven?
4. Wat doet u zelf om tijdens een periode van nachtdiensten beter of meer te slapen?

5. Wat weet u over het werken van nachtdiensten en gezondheid?
6. Hebben jullie met collega's daar onderling ook wel eens over?

Slaap (5 minuten)

1. Wat betekent slaap voor u?
2. Hoe beschrijft u een 'goede nacht slaap'?
3. Bent u tevreden over uw eigen nachtrust? Op een schaal van 1 tot 10.
4. Waarom geeft u dit cijfer?
5. Welke factoren beïnvloeden uw slaap?
6. Wat zou u aan uw eigen nachtrust willen verbeteren?
7. Wat gebeurt er als u niet goed slaapt? Welke invloed heeft dat op u?
8. Hoe beïnvloedt dit uw dagelijkse leven het meeste? Wat kan je anders niet wat je nu wel kan? Wat is er anders?
9. Doet u iets specifiek om zo goed mogelijk te slapen?
10. Hoe belangrijk is goede slaap voor u?

Gezondheid in het algemeen (5 minuten)

1. Wat betekent gezondheid (of gezond zijn) voor u?
2. Hoe voelt het om gezond te zijn?
3. Hoe gezond zou u zichzelf inschatten? Op een schaal van 1 tot 10.
4. Waarom geeft u dit cijfer?
5. Zijn er condities of ziektes waardoor u minder gezond bent?
6. Doet u iets specifieks om gezond te blijven of om nog gezonder te worden?
7. Hoe belangrijk vindt u uw gezondheid?

Onderzoek

1. Hoe goed kon u de vragenlijsten invullen tijdens de nachtdiensten en gedurende de maand?
2. Zijn er verbeterpunten?

Bedankt voor alle informatie, heeft u nog vragen?

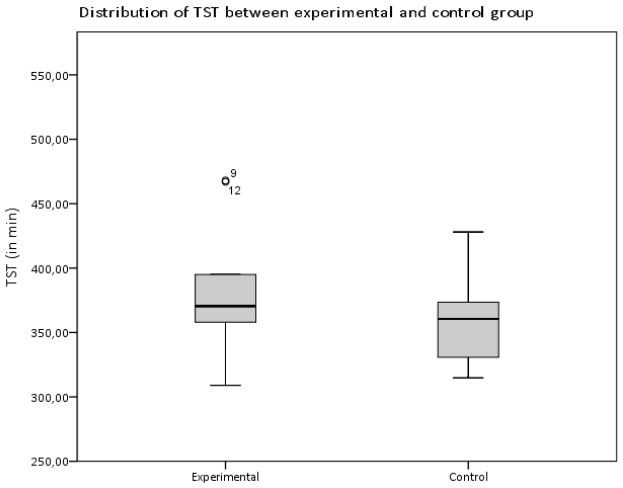
Appendix B

Coding scheme interviews

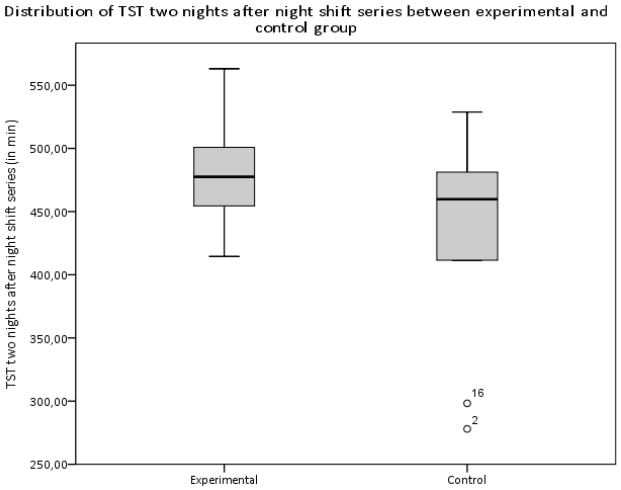
Topic	Codes	Label	Quote
Attitude split-sleep	Thoughts		
	Positive attitudes		
	Pro's		
	Cons		
Subjective norm split-sleep	Attitudes of direct environment		
	Attitudes for the future		
	Influence on intentions		
Perceived behavioural control split-sleep	Difficulty (1 very easy, 10 very hard)		
	What makes it easy		
	What makes it hard		
	Strategies to make it easier		
Intention split-sleep	Yes		
	No		
Attitudes towards nightshifts	Positive attitudes		
	Negative attitudes		
	Pro's		
	Cons		
Attitudes towards sleep	Good sleep		
	Grading own sleep pattern outside of night shifts (1 very bad and 10 really good)		
	Explanation grading		
	Strategies to improve sleep		
	Importance of sleep		

Attitudes towards health	Good health
	Grading own health (1 very bad and 10 very good)
	Explanation of grade
	Health problems
	Strategies to stay healthy
	Importance of good health
Attitudes towards night shift and health	Thoughts
	Discussion with colleague
Attitudes towards the study	Thoughts
Attitudes towards study tests	Thoughts on the tests
	Watch
	Diary
	Reaction time task

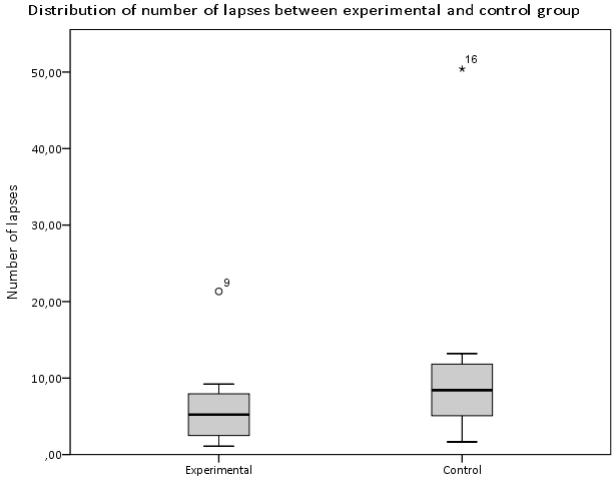
Appendix C



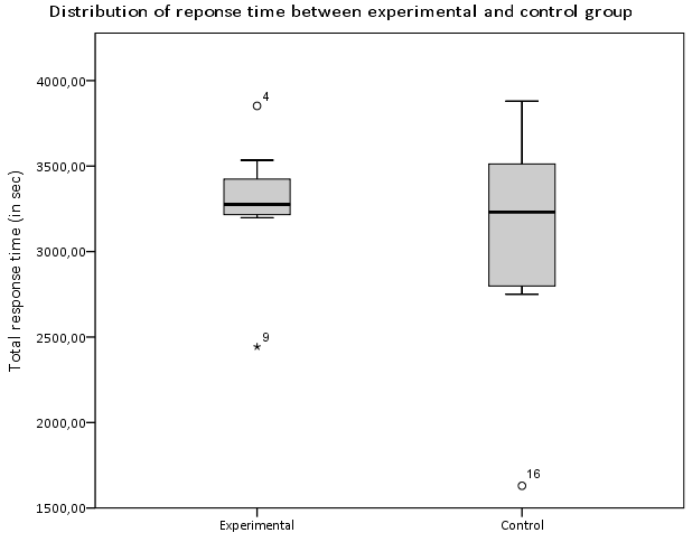
a



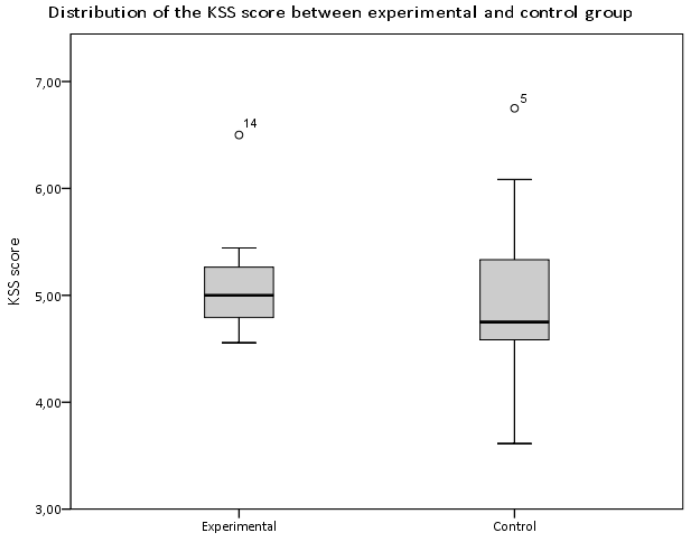
c



b



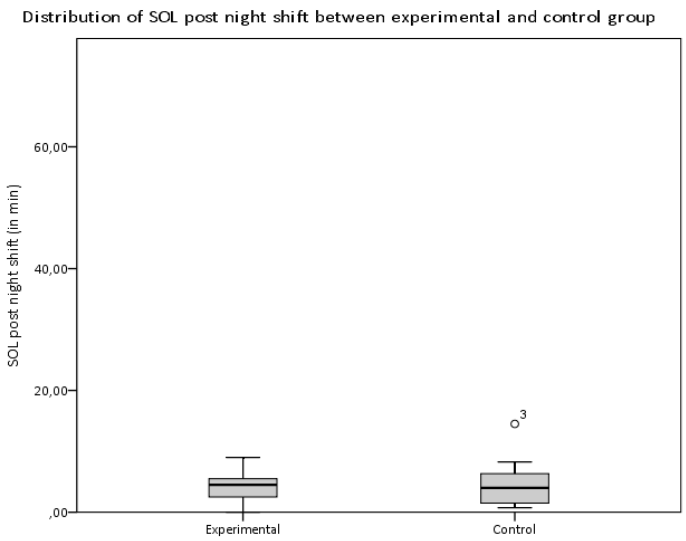
d



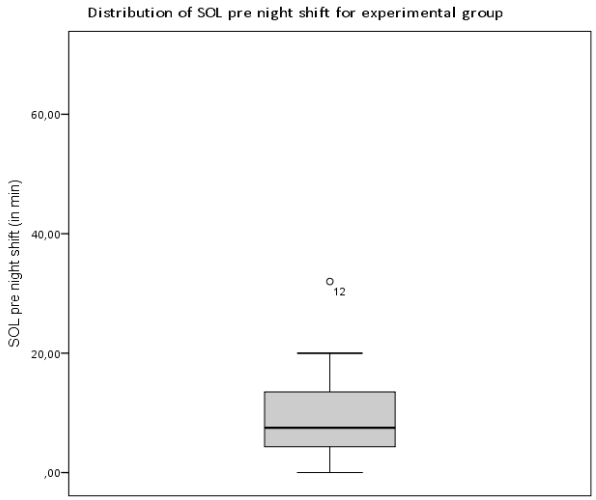
e

Figure 10. Distributions of TST; TST two nights after night shift series, number of lapses, response time and KSS scores for split-sleep and consolidated group.

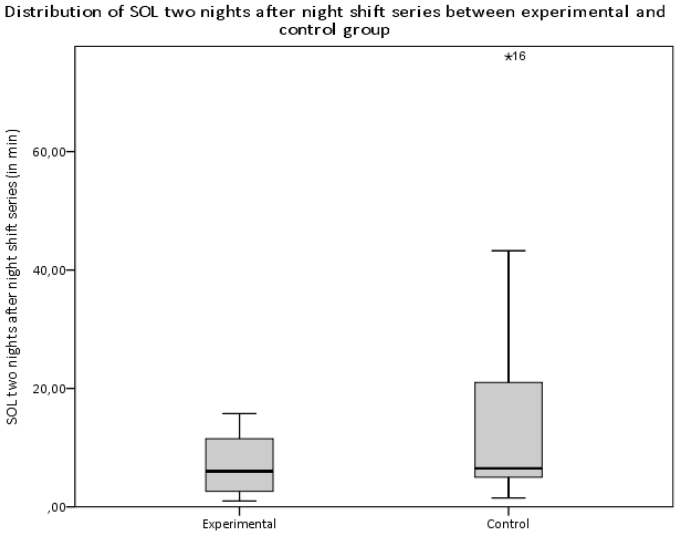
Note. TST = total sleeping time; min = minutes; lapses = RTs > 500 ms; sec = seconds; KSS = Karolinska sleepiness scale.



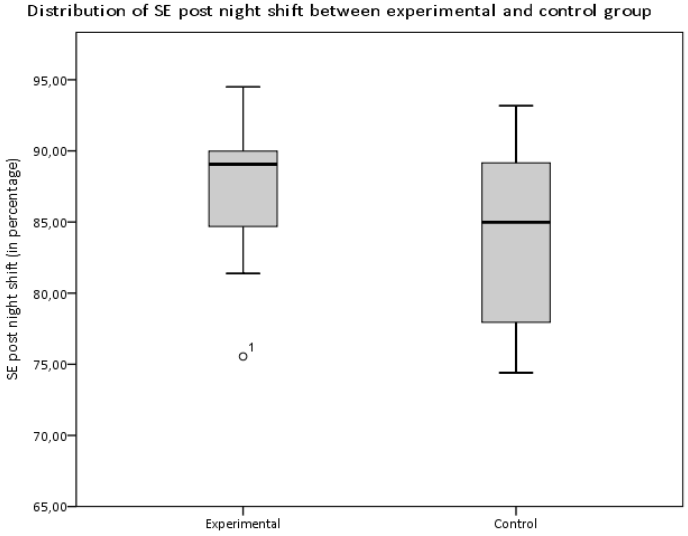
a



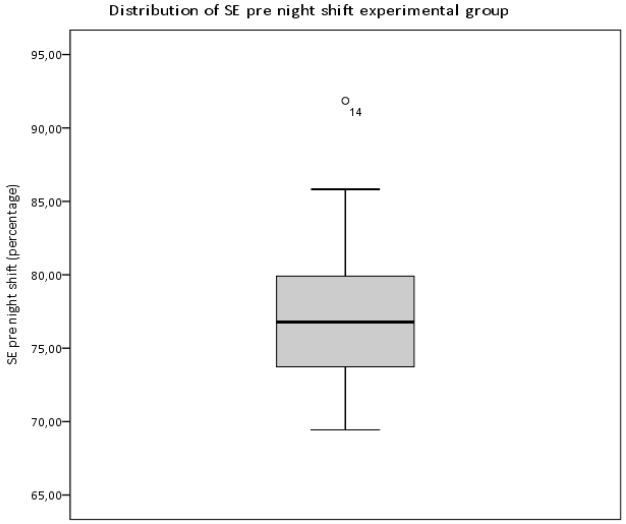
b



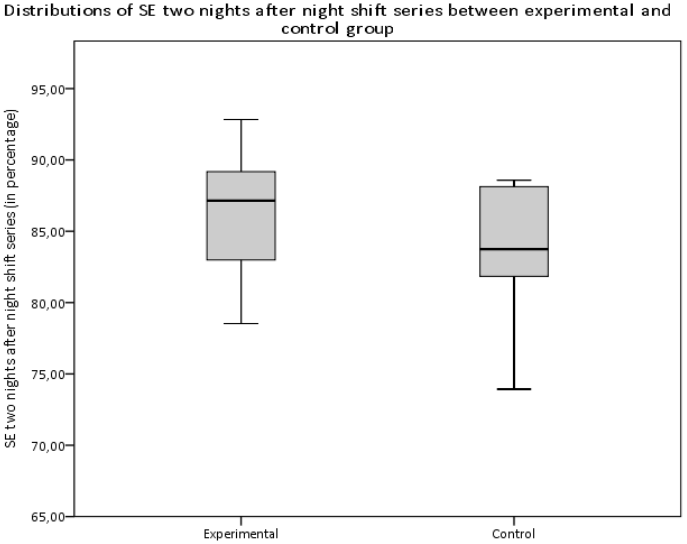
c



d



e



f

Figure 11. Distributions of SOL and SE of post night shift and two nights after night shift series between split-sleep and consolidated group. Second the SOL and SE pre night shift of the split-sleep group.

Note. SOL = sleep onset latency, SE = Sleep efficiency

Appendix D

Persona 1: *" The one that slept fine before, loves the split-sleep schedule and will continue to do so"*

Laura is 26 years old works has a nurse fulltime. Lives with her partner, has no children. She works every month one series of 4 night shifts. She has done this over the past 3 years.

Laura likes the split-sleep schedule and intends to continue doing so. She sees more advantages rather than disadvantages from the split-sleep schedule for both work and her private life. It is easy for her to follow the schedule. Falls easy asleep and had no problems with getting up. Has some basic knowledge about the impact on health. Considers herself as an easy sleeper. She has no health complains although she would like to exercise more and eat healthier. She wants to be informed about the split-sleep schedule, because she sleeps okay during the day and splitting sleep is not something she would try out of herself.

LaRouge classification	Interview segment	Type: "the one that slept fine before, loves the split-sleep schedule and will continue to do so"	Sample quotes	Translation to persona
Demographics		Dutch female, 26 years, works as a nurse in the Catharina Hospital Lives together with her partner. Works fulltime (5 days a week) Works 3 years every month a series of 4 night shifts		Laura is a 26 year old female and lives with her partner. She has no children. Laura works full time as a nurses and works every month one night shift series of 4 shifts.
Healthcare specifics: (current) practice or behaviour	Attitudes towards split-sleep	Likes the split-sleep schedule and wants to keep doing so. Sees more pro's than cons of the split-sleep schedule	*"….dat ga ik voortaan altijd doen".* *"...dan heb je wat aan je dag... als mijn vriend vrij is die dag dan heb je 's middags nog wat aan elkaar, 's avonds kun je minder doen... ik merkte wel dat als ik in 1 keer slaap dat je 's avonds zo moe bent als je op staat... en dan is het eerste gedeelte van de nacht al zwaar... en met 2 keer slapen dan blijft het tweede gedeelte zwaar, maar met 1 keer slapen was het eerste gedeelte al rot... het wel wat makkelijker om wakker te blijven".* *"...dat om 22.00 uur je bed uit en dan denk ik, ik heb echt geen zin... en je bent continu aan het rekenen van oké, oké, hoe laat moet ik dan*	Laura likes the split-sleep schedule and wants to continue. She has experienced the split-sleep schedule as very positive, both for work and private life.

			naar bed en hoe laat moet ik dan weer opstaan".	
	Subjective norm	Direct environment finds shift work in general hard. However, they have no problem with the split-sleep schedule.	*"Maar die vindt sowieso onregelmatig lastig... die vind het helemaal geen probleem".*	Her direct environment has no problem with the split-sleep schedule.
	Perceived behavioural control	Difficulty in following the schedule	*"ik vond het eigenlijk wel heel makkelijk om gewoon aan de tijden te houden en om op tijd mijn bed uit te gaan.."*	She finds is easy to follow the split-sleep schedule.
	Working night shifts and health	Knowledge about working night shift and health is medium.	*"Volgens mij is het totaal niet goed voor je. Ik weet dat er een aantal onderzoeken zijn gedaan naar risicofactoren zoals het krijgen van borstkanker en het vitamine tekort die je kunt krijgen bij het werken van nachtdiensten".*	Knows that working night shifts is unhealthy and knows the increased risk of breast cancer and vitamin deficiency.
	Sleep	Views own sleep pattern as fine	*"ja ik slaap eigenlijk altijd wel goed. ik kom niet zo moeilijk in slaap vallen. Dat gaat bij mij eigenlijk heel makkelijk, ik kan overal of onder welke omstandigheid slapen. Daar heb ik eigenlijk geen problemen mee". "...sommige nachten zijn wel minder... omdat ik soms toch wel wakker word 's nachts om naar de wc te moeten of na een stressvolle dag dat ik dan minder goed slaap of ook wel eens droom over wat er op het werk gebeurt is".*	Laura is an easy sleeper. Sleeps when and when she wants. Some night she sleeps less, because she wakes-up for the bathroom or is still processing stressful events during the day. But in general she sleeps fine.
	Health	Views own health		She reviews her health

		as good, some behavioural issues to change	*"Ik kan eigenlijk alles doen wat ik wil doen. Maar het kan altijd beter. Ik zou wel wat meer willen sporten... En qua eten... We [ik en mijn vriend] wonen niet samen dus we reizen veel op en neer, daardoor is eten lastiger".*	with a 9. Has no health complains although would like to exercise more and eat more healthy.
		Had no knowledge of a split-sleep schedule	*"Ja zelf ga je dat niet zo zeer uitproberen. Als je daar geen nut voor hebt dan denk je ah nou ja ik zie wel wanneer ik slaap, maar juist met zoiets dan denk ik van ja.."*	She wants to be informed about the split-sleep schedule. It is not something she should try out of herself.
Technical	Technological	Is familiar with basic technological devices	*"telefoon, computer, laptop. Ipad.."*	She is familiar with a smartphone, laptop, computer, Ipad, and uses these on a daily basis.
		Application use	*"ja ik heb wel eens gekeken naar zo'n calorieënteller, maar daar hecht ik niet zoveel waarde aan... daar moet je al je producten in gaan voeren en dan denk ik ja, wat bereik ik er nu mee, nu weet ik hoeveel ik gegeten heb, ga ik het aanpassen? Nee".*	She has used health applications out of curiosity. However, easily quits using, because she does not see a need for change.
		Thoughts towards an application	*"Als het specifiek genoeg is, dus echt voor verpleegkundigen die fulltime werken met wisselende diensten, dan kijk ik daar wel op. Dan ben ik wel nieuwsgierig, hoe en wat, welke tips het zou geven. Wat ik er aan zou hebben"*	Is open to a health application if it is specific tailored to nurses who work fulltime.

Persona 2: *" The one that slept fine before, sees advantages of the split-sleep schedule although will only implement it when it fits his/her personal life"*

Chantal is a fulltime nurse at the Catharina Hospital. She is 24 years old, lives with her family and works monthly a series of 4 night shifts. She has 3 years of experience in working night shifts.

Chantal has experienced the split-sleep schedule as better than expected. The advantages and disadvantages she values in balance. Her family finds it less cosy, although for them it is not an obstacle. In terms of sleep it is easy for her to follow the split-sleep schedule but sleeping one time is easier. She will sometimes implement the split-sleep schedule. She sees the advantage for working, although her private life is valued as more important. She will not change her schedule and she wants to plan or when activities are already planned during the evening. She believes that the health damage has already taken place and she is not planning on working night shifts for the rest of her life. She is only motivated when she gains a direct advantage. She is satisfied with her sleep and thinks she is a good sleeper. Sleep is not her main priority. Chantal is healthy, she exercises and eats healthy. Health is important to her, although she is sometimes more busy with taken care of others rather than herself.

LaRouge classification	Interview segment	Type: "The one that slept fine before, sees advantages of the split-sleep schedule although will only implement it when it fits the planning".	Sample quotes	Translation to persona
Demographics		Dutch female, 24 years, works as a nurse in the Catharina Hospital Lives with family Works fulltime (between 5 and 6 days a week) Works 3 years every month a series of 4 night shifts		Chantal is 24 years old and works fulltime as a nurse at the Catharina Hospital. She lives with her family, has no children and has 3 years of experience with working night shifts.
Healthcare specifics: (current) practice or behaviour	Attitudes towards night shifts	Attitude is positive	*"….Het is me eigenlijk best goed bevallen...ik vind het echt meevallen".*	Chantal experienced the split-sleep schedule as better than expected.
		In general pros and cons are in balance	*"Het is wel iets minder gezellig, want mijn vriend is natuurlijk 's avonds thuis en dan ga ik weer naar bed. Dus dat is wel een stukje minder gezellig, maar het was mooi weer dus ik vond het al lang best.... Je ziet en wat meer van de dag en met mooi weer dan kun je daar toch net wat meer van genieten, dan wanneer je tot 17.00 uur slaapt en dan uit je bed komt".*	Next to her positive attitude the amount of pros and cons she named are balanced.
	Subjective norm	Less cosy, but had no problem when continuing. Night shifts are not forever	*"ja wel iets minder gezellig, natuurlijk haha, als ik 's avonds moest slapen...nou ja op zich vindt hij het niet heel erg en hij zegt*	Her family found it less cosy with her sleeping during the evening. Although it is not viewed as an obstacle by the environment.

			ook van ik ben blij dat het niet altijd is".	
	Perceived behavioural control	In general participants found it easy to follow the schedule. However, it is harder when the series of shifts is longer	*"Ik vond het echt niet moeilijk.... de eerste nachtdiensten zou ik het een 3 geven of zo, dan is het wel goed te doen. Maar niet zo makkelijk als in 1 stuk slapen. En de laatste 2 nachtdiensten, als ik er bijvoorbeeld 5 deed, dan was het toch echt wel een 6/7".*	She finds it easy to sleep in two times. Although it is harder compared to sleeping one time. In addition, splitting sleep is harder when the series of night shifts are longer.
	Intention to continue	Participants would not always split their sleep. Social life is viewed as more important.	*"Het is ook niet zo dat ik denk van ik zal dit altijd zo gaan doen. Ik zou het wel af en toe zo doen. Bijvoorbeeld met mooi weer, in de winter of bij 2 of 3 nachtdiensten. Maar ik zou geen afspraak in de avond verzetten....dan is het kwaad toch al geschied...maar ik hoop ook dat ik niet altijd nachtdiensten hoef te werken".*	She will sometimes implement the split-sleep schedule when the weather is nice, in winter or with a short series of night shifts. Although she will not change her schedule and activities during the evening will not be canceled. The possible damage has already taken place. In addition she is not planning on working night shifts the rest of her life.
	Working night shifts and health	In general participants know that working night shifts is unhealthy based on own complaints or on complaints of colleagues	*"Ik weet dat het niet heel gezond is... de ene krijgt last van zijn darmen de ander heeft last van zijn schildklier erbij, de een slaapt niet overdag en krijgt daar dan weer heel veel problemen mee. En de misselijkheid dan dat is ook wel een dingetje..."*	She is aware of some health issues. However, knows only short-term risks.
	Sleep	Participants viewed their sleep as good.	*"Ik slaap over het algmeen wel goed... ik lig zelden helemaal wakker 's nachts".*	She is satisfied with her sleep. Views it as good. Rarely lies awake.
		Sleep is semi important. Other activities can be	*"Ik vind slapen wel belangrijk, maar zonder slaap kan ik ook bezig blijven.... ik*	She finds sleep semi important. Chantal can function with less sleep

		viewed is more important.	*vind slapen niet het belangrijkste in dat ik bijvoorbeeld heel lang moet uitslapen of 's avonds heel op vroeg naar bed moet".*	and to her it is not important to sleep in or go to bed early.
	Health	Participants viewed their health as important and make an effort the stay healthy. None had health complaints.	*"Ik ben echt wel gezond. Ik sport veel, voel me fit en gezond eten vind ik belangrijk. Maar je kunt best af en toe wat ongezonds eten. Gezondheid is voor mij belangrijk want van je gezondheid hangt verder af hoe je je voelt, hoe je functioneert, ook hoe gelukkig dat je bent, maar ik ben [soms] meer bezig met anderen dan met mezelf".*	Chantal is healthy. She exercises and eat healthy. Health is rated as important in influences one's wellbeing. Although she is sometimes more busy with taken care of others rather than herself.
Technical	Technology	Basic widely accepted devices.	*"ik heb thuis een laptop en mijn smartphone, tablet, tv".*	Chantal uses well known integrated technological devices, such as a smartphone, tablet and television.
		No innovation needs	*"nee, ik denk een beetje normaal. Ja als het maar goed werkt".*	For Chantal technique has to work. She is not someone who always wants the newest products.
		History of application use.	*"nee eigenlijk niet, nooit echt bij nagedacht om daarmee bezig te zijn".*	She has not and currently is not using health application. It does not interest her.
		Is open for an application tailored to shift workers	*"ja, ik denk het wel. Ik denk dat ik het wel interessant zou vinden om te zien, als er tips op zouden staan... [bijvoorbeeld] wat het beste slaappatroon of voedingspatroon is...dat je met nachtdiensten een vast eetpatroon krijgt, dus een vast tijdsstip wanneer je moet eten*	If there is an application for shift workers she is open to use it. She would like to see tips about sleep, food (to create more regularity) and exercise during night shifts. In addition she would like to see her sleep pattern and daily activity.

			[of] wat je het beste kunt eten. Of misschien qua sporten wat het beste is om te doen tijdens de nachtdiensten...[of] dat je kunt zien hoe goed je geslapen hebt...en hoe actief je bent geweest".	
		Open for an alarm feature	*"Ja, misschien zou het wel werken om meer ritme te houden".*	Chantal thinks an alarm feature could work to keep more rhythm.

Persona 3: *"The one that sleeps badly during nights shifts series and has to split-sleep to obtain enough hours of sleep"*

Lisa is a 25 year old female, who lives together with her partner in Eindhoven. She works fulltime as a nurse and has 4 years of experience with working night shifts. She works monthly one series of 4 shifts.

During the nights shifts she is a bas sleeper. She wakes up early, after only 3 or 4 hours of sleep, even with precautions (e.g., wearing earplugs). Before the study she already took a nap in the evening in order to function during the night. She experiences advantages and disadvantages. Her partner has no problem with the split-sleep schedule, he can do his own thing. However, Lisa found it hard to go to bed during the evening, although she knows she needs it. She had to continue with the split-sleep schedule in order to stay awake during the night. She would like to sleep in once, because it is closer to her normal rhythm. Her knowledge about working night shifts and health is medium. Her knowledge is mainly based on physical complaints she gets. Outside of the night shifts she sleeps fine and has no health complaints. Health is very important to her and she makes healthy choices every day.

LaRouge classification	Interview segment	Type: "The one that sleeps badly during nights shifts series and has to split-sleep to obtain enough hours of sleep"	Sample quotes	Translation to persona
Demographics		Dutch female, 25 years, works as a nurse in the Catharina Hospital Lives together with her partner Works fulltime (5 days a week) Has 4 years of experiences with working night shifts		Lisa is 25 years old, lives together with her partner in Eindhoven and they have no children. She works fulltime as a nurse at the Catharina Hospital. She has worked the past 4 years every month 4 night shifts.
Healthcare specifics: (current) practice or behaviour	Attitudes towards night shifts	Likes the schedule has to do it to function	*"ja, met nachtdiensten kan ik sowieso eigenlijk niet goed slapen zeg maar. Dus laatst was ik om 11.00 uur al wakker en dan ben ik heel blij als ik 's avonds nog even kan slapen of moet gaan slapen".*	Lisa is a bad sleeper during a series of night shifts. She wakes-up early and cannot sleep further during the day. She needs the split-sleep schedule to function during the night.
		Sleep times were fine. There is no perfect sleep schedule that works for everyone	*"nee ik denk dat het heel persoonlijk is voor iedereen. Een advies is heel lastig, omdat dat voor iedereen zo verschillend [is]".*	She has no improvements for the current intervention. For her it is fine. However, she believes that a general advice is challenging, because people differ too much.
		The split-sleep schedule has pro's and cons. These are in balance	*"ik heb zelf het gevoel dat ik wat meer aan mijn dag heb...Het is alleen, ja, je bent dan heel veel bezig met slapen zeg maar".*	She sees pro's of the schedule, seeing more of the day. However, it also has some disadvantages, e.g., being preoccupied with sleep.
	Subjective norm	Fine, they can do there on thing	*"als ik weg ga gaat hij naar bed en hij is hele dag werken en dan komt hij thuis en dan ben ik toch al wakker, dus ik weet niet of hij er*	Lisa's partner has no problem with the split-sleep schedule. He can do his own thing.

			echt heel veel last van heeft. Plus dan ga ik 's avonds slapen en dan kan hij voetbal kijken, dus ik denk dat hij er niet heel veel problemen mee heeft".	
	Perceived behavioural control	In general participants found it hard to go to bed in the evening, wanted to do social activities	*"ja ik vind het 's avonds best moeilijk, want dan is mijn vriend ook thuis en dan gaan we eten end an vind ik het zo zonde om dan neer bed te gaan, want dan zie ik hem helemaal niet... of met het warme weer dan denk je oh ik zou nu ook wel gewoon even ergens op het terras willen gaan zitten of zo, maar dat gaat dan niet, omdat je moet gaan slapen. Ik vind het dan wel heel lastig om naar bed te gaan".*	Lisa found it hard to go to bed in the evening. She wants to spent time with friends and boyfriend.
	Intention to continue	Participants will continue with the split-sleep schedule because they need it	*"Ja ik denk het wel, denk dat het voor mij wel fijn is eigenlijk... dat moet ik ook gewoon blijven doen. Maar als het me lukt om door te slapen dan vind ik het denk ik wel prettiger [om 1 keer te slapen], omdat het dan iets meer bij je ritme hoort zeg maar. Dus dat je gewoon 1 keer slaapt en dan gewoon de dag begint".*	Lisa has to continue with the split-sleep schedule, because she cannot sleep enough during the day. She also did it before.
	Working night shifts and health	Knowledge is low	*"je darmen zijn van streek en je eet veel meer als je nachtdiensten hebt. [en] ze zeggen dat je een grotere kans op borstkanker hebt. Dat is het enigste wat ik weet".*	She experiences some bowel issues and based on that knows it is not healthy. In addition, she knows the increased risk of breast cancer.
	Sleep	Outside of night shifts	*"normaal in het dagelijks leven [slaap ik*	Normally she sleeps fine. Really wake ups up during

		participants viewed their sleep as good	*goed]...ik kan goed doorslapen...ik lig heel vaak gewoon en ik ben dan meteen weg en ik word pas wakker als de wekker gaat..."*	the night and falls easily asleep. Wakes up from the alarm.
		Strategies taken during night shift to improve sleep	*"eerst pakte ik met nachtdiensten wel melatonine, maar als ik een normaal ritme heb dan niet.... oordopjes, hele donkere gordijnen en bel eruit".*	She takes sometimes melatonin with night shifts, wears earplugs, has very dark curtains and turns off the doorbell.
	Health	Participants have no health complains	*"Ik ben helemaal gezond".*	Lisa is perfectly healthy.
		Health is very important and daily healthy choices are made	*"ik vind dat wel heel belangrijk. Ik probeer wel elke dag met eten op te letten, ik eet heel veel groenten, weinig vlees, ik drink geen frisdrank maar altijd water of groene thee en probeer maar 2x keer per dag koffie te drinken".*	Health is very important to her. She pays attention to food. Eat a lot of vegetables, not much meat, no soda and only 2 cups of coffee a day.
Technical	Technology	Basic widely accepted devices. Uses these daily.	*"Laptop, mobiel. Verder niet denk ik".*	Lisa uses daily her smartphone and laptop.
		History of application use.	*"ik heb ooit een app gehad die ging meten hoe goed of je hoe diep je slaapt en hoe vaak je wakker wordt".*	Has used a sleep app to see how deep one sleeps and how many times one wakes up.
		Started out of curiosity	*"ja gewoon uit nieuwsgierigheid...we deden er verder ook niks mee. Het was ook gewoon voor de leuk".*	She downloaded the app out of curiosity. She used it just for fun.
		Quitted because the sleep pattern was the same	*"het was wel een beetje hetzelfde elke keer. Ik denk dat we hem 2 maanden gebruikt hebben".*	The information the app gave became the same, so after two months she quitted.
		Unsure what an application can add.	*"nou dat weet ik niet, als het een app is die zorgt dat ik beter*	Lisa had not a clue what an app can add. She would look at it out of curiosity

			slaap… ik zou het niet weten wanneer ik hem zou gebruiken eigenlijk. Maar uit nieuwsgierigheid om dingen na te kijken [zou ik er wel voor open staan]".	but had no input for features.

Persona 4: *"The one that sleeps fine in once, cannot execute the split-sleep schedule and beliefs it is not for everyone"*

Linda is a nurse of 23 years old at the Catharina Hospital. She works fulltime and over de past 2 years she works every month a series of night shifts. She lives together with her boyfriend.

Linda started with the split-sleep schedule, however she had to drop-out because she could not sleep during the evening. Although, she sees the relevance and possible advantages of the split-sleep schedule, she believes the split-sleep schedule is not suitable for everyone. She sleeps perfect during the day.

LaRouge classification	Interview segment	Type: "The one that sleeps fine in once, cannot execute the split-sleep schedule and beliefs it is not for everyone"	Sample quotes	Translation to persona
Demographics		Dutch female, 23 years, works as a nurse in the Catharina Hospital Lives with her boyfriend Works full time (5 days a week) Has 2 years of experiences with working night shifts		Linda is 23 and works as a nurse in the Catharina Hospital. She works fulltime and has 2 years of experiences with working night shifts. She lives with her boyfriend.
Healthcare specifics: (current) practice or behaviour	Attitudes towards night shifts	Dropped-out could not sleep during the nap. Sees pro's of the schedule.	*"Maar om dan 's avonds weer terug naar bed te gaan dat deed ik dan wel, maar ik kwam niet in slaap...ik word daar ook gewoon onrustig van. Ik ben bang dat ik me verslaap...dat ik te diep in slaap val en juist niet wakker kan worden... [ik bedenk me] ik ben eigenlijk niet moe en dan [denk ik] ik had eigenlijk dat en dat kunnen doen... en als ik dadelijk wel slaap dan ben ik misschien weer te moe [als ik wakker word]".* *"ja, ik vond het wel zonde....want als*	Linda started with the split-sleep schedule, however she could not sleep during the evening nap, got seriously sleep deprived and had to drop-out. She sees the relevance of splitting sleep.

			het je lukt dat gesplitst slapen dan zie ik echt wel de voordelen ervan... ik denk wel dat je dan ook wel frisser je nachtdienst begint, want als je dan heel de dag slaapt dan ben je rond een uur of 17.00/18.00 uur wakker en dan moet je als nog een hele ruk".	
	Subjective norm	They were not around	*"nou mijn vriend was op reis dus die was er niet, dus dat maakt het wel wat makkelijker".*	Her boyfriend was not around when she tried the split-sleep schedule.
	Perceived behavioural control	Believes there are no strategies to make it easier or feasible.	*"nee ik denk dat gesplitst slapen gewoon niet voor mij weggelegd is. Ik denk gewoon echt dat aan 1 stuk is voor mij perfect. Ik slaap ook gewoon overdag super. En ik heb eigenlijk nooit, of ja ik word dan wel 1 of 2 keer wakker, maar dan is het 2 tellen en dan slaap ik weer verder".*	She believes that split-sleep is not intended to be effective for everyone. She sleeps perfectly fine during the day.
Technical (is missing, did not came across in these interviews)				