

SLEEP MISPERCEPTION IN CAREGIVING AND NONCAREGIVING OLDER ADULTS

By

PAMELA DUBYAK

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To my Mom and Dad

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LIST OF ABBREVIATIONS

NREM	Non-rapid eye movement
REM	Rapid eye movement
SOL _o	Objective sleep onset latency
SOL _s	Subjective sleep onset latency
TST _o	Objective total sleep time
TST _s	Subjective total sleep time
TWAK _o	Objective terminal wakefulness
TWAK _s	Subjective terminal wakefulness
TWT _o	Objective total wake time
TWT _s	Subjective total wake time
WASO _o	Objective wake after sleep onset
WASO _s	Subjective wake after sleep onset

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Pamela Dubyak

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This study examined sleep misperception - the discrepancy between subjective total wake time (TWT_s) and objective total wake time (TWT_o) - in older adult dementia caregivers and older adult noncaregivers. Thirty-one caregiving (mean age=70.48 years, $SD=7.55$) and 103 noncaregiving (mean age=72.90 years, $SD=6.86$) older adults completed one week of sleep diaries and actigraphy. Participants were defined as good or poor sleepers, resulting in 4 groups: good sleeping noncaregivers, poor sleeping noncaregivers, good sleeping caregivers, and poor sleeping caregivers. Due to the small number of good sleeping caregivers ($n=4$), they were excluded from further analyses. Sleep misperception was defined as $[(TWT_s - TWT_o)/TWT_o * 100]$. Wilcoxon Signed-Rank tests were conducted for each group and revealed significant differences between TWT_s and TWT_o for good sleeping noncaregivers and poor sleeping noncaregivers, but not for poor sleeping caregivers. Poor sleeping caregivers' data, however, were reaching significance ($p = 0.06$). Chi-square analyses revealed group differences in the proportion of misperceivers with 100.00% of poor sleeping noncaregivers misperceiving compared to 55.90% of good sleeping noncaregivers and 50.00% of poor sleeping caregivers. The Kruskal-Wallis test revealed significant between group differences in misperception. Specifically, poor sleeping noncaregivers exhibited more sleep misperception than both good

sleeping noncaregivers and poor sleeping caregivers. Good sleeping noncaregivers and poor sleeping caregivers were statistically similar ($p > 0.05$). According to the Harvey model of insomnia maintenance, poor sleeping caregivers should be experiencing the most sleep misperception of the three groups. The literature indicates that dementia caregivers experience high levels of cognitive arousal, physiological arousal, and anxiety during the night in comparison to the other groups. This arousal and anxiety, according to the Harvey model, should induce sleep misperception. These results, however, indicate that this is not the case. One hypothesis for these results is that some of the cognitive and physiological arousal these caregivers experience aid in time estimation instead of sleep misperception. Specifically, arousal related to nightly chores may help with total wake time estimation. Since the caregivers are focused on the chores and not their sleep, they may be able to estimate better. These chores, instead of creating anxiety about not sleeping, distract the caregiver from negative thoughts about sleep and focus more on the activity. This focus and attention on the chores may aid in consistent total wake time estimates. Poor sleeping noncaregivers in turn may only experience the anxiety-inducing and sleep misperception-causing cognitive and physiological arousal. Since noncaregivers are most likely not performing planned activities during the night, they may be lying awake in bed and focusing their attention on not sleeping, which induces sleep misperception. These data suggest that poor sleeping caregivers may have tools to help them report consistent total wake time events and therefore have similar amounts of sleep misperception in comparison to good sleeping noncaregivers.

CHAPTER 1 INTRODUCTION

The current study examines sleep misperception in older adult caregivers of dementia patients and older adult noncaregivers. Sleep misperception is defined as the difference between a subjectively measured sleep variable and an objective measure of that same sleep variable (Tang & Harvey, 2004). This study will investigate whether misperception of total wake time occurs in older adult caregivers of dementia patients, and whether this group's amount of sleep misperception differs significantly in comparison to older adult noncaregivers.

There has been a large contribution of research looking at the lives of dementia caregivers and their quality of life. However, even within the vast amount of research in this area, there has been a paucity of research on caregivers. Currently, 5.8 to 7 million adults are informal caregivers to adults over the age of 65 (U.S. Department of Health and Human Services, 1994). In addition, about 30 % of these caregivers are over the age of 65 themselves (U.S. Department of Health and Human Services, 2001). Older adult caregivers constitute a large portion of the population. In addition, although poor sleep is a common complaint within both the caregiving and older adult communities, sleep misperception has not been fully investigated in either group (McCurry, Logsdon, Teri, & Vitiello, 2007; National Sleep Foundation, 2003). This is unexpected since researchers have noted that sleep complaints in dementia caregivers are multifaceted and objective sleep findings do not match these caregivers' sleep complaints (McCurry et al., 2007). A better understanding of sleep misperception in older adult caregivers of dementia patients may contribute to a better understanding of their poor sleep complaints.

CHAPTER 2 REVIEW OF THE LITERATURE

Sleep and Older Adults

As individuals age, their sleep patterns change. Babies enter sleep with REM (rapid eye movement) sleep as opposed to NREM (non-rapid eye movement) sleep and have short NREM-REM cycles (approximately 50 minutes in length; Carskadon & Dement, 2005). Over time, individuals begin to enter sleep through stage I of NREM sleep and their NREM-REM sleep cycles lengthen to 90 minutes (Carskadon & Dement, 2005). During adolescence, NREM stage III and IV sleep decrease by 40% (Carskadon & Dement, 2005). As individuals enter older adulthood, these changes to their sleep continue. First, their quality of sleep begins to decrease (Morgan, 2000). Second, average total sleep time decreases from seven hours per night to six hours per night (Nau, McCrae, & Lichstein, 2005). Third, sleep efficiency (percentage of time spent asleep divided by time spent in bed) decreases from an average of 90% to 70-80% (Bliwise, 2005). This means that older adults spend more time awake in bed than asleep. Fourth, daily total sleep time is more variable in older adults in comparison to younger adults (Nau et al., 2005). Fifth, as people age, the number of nighttime arousals increase (Morgan, 2000). Specifically, older adults report an average of eight awakenings per night (Nau et al., 2005). Sixth, the length of the sleep stages changes with age. The length of NREM (non-rapid eye movement) stages I and II (often referred to as “light sleep”) increase, while NREM stages III and IV (often referred to as “deep sleep”) decrease (Morgan, 2000; Nau et al., 2005). Individuals are more easily aroused during NREM stages I and II. Seventh, older adults shift between sleep stages more frequently than younger adults (Morgan, 2000). Although these changes in sleep architecture occur in both men and women, the deterioration is significantly worse in men (Morgan, 2000). It is important to note, however, that women are more likely to complain about

their sleep and seek help for their poor sleep than men (Bliwise, 2005; Morgan, 2000). Finally, older adults spend more time napping than younger adults, which can create a reduction in the homeostatic drive for sleep at night (Nau et al., 2005).

Poor Sleep and Older Adults

According to the National Sleep Foundation (2003), 48% of older adults complain of at least one insomnia symptom three times or more per week. About 30% of adults over the age of 65 report sleep maintenance difficulties and 15% report problems at sleep onset (Bliwise, 2005). In a study with over 9,000 participants aged 65 and older, 57% complained of one or more sleep disturbance occurring most of the time, 29% stated that they had difficulty falling asleep or woke up too early in the morning, and 13% reported rarely waking up feeling rested (Foley, Monjan, Brown, Simonsick, Wallace, & Blazer, 1995). Although some of these sleep complaints may be related to the change in sleep architecture during the aging process, these sleep complaints are related to multiple factors. In a study by Vitiello, Moe, and Prinz (2002), it was found that geriatric sleep complaints were primarily associated with medical and psychiatric disorders and other health factors. In their study, they analyzed sleep data from two groups of older adults. In the first group of 1619 older adults only 3.14% reported sleep complaints that were not related to health factors (Vitiello et al., 2002). In the second group of 1335 older adults, 1.35% reported sleep complaints not related to health factors (Vitiello et al., 2002). These data suggest that not only is poor sleep a common complaint in older adults, but it is also associated with their health.

Sleep and Physical Health

Health status does not only act upon sleep quality in older adults; there is a strong relationship between health and sleep. In a study by Ohayon and Vecchierini (2005), the researchers looked at participants' reported sleep accounts (sleep diaries) and health status. Ohayon and Vecchierini (2005) found a link between poor sleep and poor health status. Poor

health was commonly associated with a shorter total sleep time, increased sleep onset latency, late bedtime, and early wake-up time (Ohayon and Vecchierini, 2005). Ohayon and Vecchierini (2005) also noted an association between obesity and a low total sleep time and a late bedtime. Ohayon and Vecchierini (2005) postulated that sleep deprivation may be associated with changes in metabolism which are in turn related to weight gain. There is an association between a lack of physical exercise and people who sleep between 4 to 6 hours per night (Ohayon & Vecchierini, 2005). In another study, a link between insomnia and a decrease in health-related quality of life (according to the SF-36) was noted (Schubert, Cruickshanks, Dalton, Klein, & Nondahl, 2002). Foley and colleagues found a relationship between poor sleep and heart disease, incident diabetes, stroke, and respiratory problems (Foley et al., 1999). This research suggests a strong relationship between chronic poor sleep and physical health.

Sleep Misperception

Sleep misperception is defined as the difference between a subjectively measured sleep variable and an objective measure of that same sleep variable (Tang & Harvey, 2004). Sleep misperception can have serious consequences. An individual who misperceives her sleep at night may react to situations differently during the day. Specifically, the misperception of sleep can play a significant role in a person's perception of her ability to function during the day. For example, an individual who perceives her sleep as poor may report poor daytime functioning even though there is no objective evidence to explain the daytime dysfunction (Semler & Harvey, 2005). In addition, the perception of poor sleep can negatively impact one's physical health. One study noted that those who perceived their sleep as poor reported significantly more chronic health conditions and daytime fatigue than those who did not (McCrae, Rowe, Tierney, Dautovich, DeFinis, & McNamara, 2005).

Harvey Model of Insomnia Maintenance

In addition to negatively impacting one's health and daytime functioning, sleep misperception plays a central role in the maintenance of insomnia. According to the Harvey model of insomnia maintenance, sleep misperception initially occurs after an individual has become cognitively and physiologically aroused (Means, Edinger, Glenn, & Fins, 2003; Tang & Harvey, 2004). Tang and Harvey (2005) found that individuals in an anxiously aroused group reported significantly longer sleep onset latency periods. Interestingly, Tang and Harvey (2005) also found that participants who were in a neutrally aroused group also reported perceiving a significantly shorter total sleep time than they actually experienced (Harvey & Tang, 2004). This data suggests that although anxiety arousing cognitions can play a large role in sleep misperception, neutral cognitions can also play a role in sleep misperception. Tang and Harvey (2004) also noted that their physiologically aroused group reported a shorter total sleep time in comparison to the non-physiologically aroused group. It is important to note that both the anxious-cognitively aroused group and the physiologically-aroused group described their sleep as poorer than the non-aroused group (Harvey & Tang, 2004).

Harvey suggests that after the individual begins to experience the cognitive and physiological arousal, sleep misperception occurs. Specifically, sleep misperception encourages additional anxiety related to not sleeping (Tang & Harvey, 2004). This anxiety then leads to worse sleep. At this point the anxiety is arousing the individual out of the state of relaxation and possible sleep (Tang & Harvey, 2004). For example, an individual may be worried about speaking at a presentation the next day. This apprehension may lead to an increased heart rate. This cognitive and physiological arousal may begin to lead to sleep misperception. At this time the individual may believe he has been awake in bed for 30 minutes, when in fact he has been awake for 10 minutes. This sleep misperception can then lead to additional arousal and

cognitions including the belief that he will never fall asleep. These new cognitions lead to further sleep misperception. Thus, according to the Harvey model, the flow of arousal is cyclical and quickly creates a state of chronic poor sleep.

Role of Sleep Misperception in Poor Sleep

It should be noted that the Harvey model of insomnia maintenance and sleep misperception does not “create” poor sleepers. Behaviors (e.g., inconsistent sleep schedule, caffeine in the late afternoon, and napping) and cognitions (e.g., thoughts regarding an acute stress) begin the poor sleep cycle. The Harvey model suggests that these behaviors and cognitions begin the insomnia cycle. Specifically, these cognitions and behaviors increase arousal which in turn induces sleep misperception. This sleep misperception generates additional arousal and anxiety, which maintains the insomnia.

Time Estimation

It is important to note that although sleep misperception is defined as individuals not being able to accurately estimate time, these individuals are not overall poor estimators of time. Individuals who misperceive their wake time during the night are typically able to estimate time in other situations. Tang and Harvey (2005) found that poor sleepers and good sleepers were not significantly different at estimating time when they were not trying to sleep. In addition, the location of the experiment did not contribute to poor time estimation. The participants in this study estimated time accurately in their bedroom environments (Tang & Harvey, 2005). Although poor sleepers (according to the Harvey model of insomnia maintenance) may be more likely to overestimate wake time in their bedrooms, they did not overestimate in this experiment (Tang & Harvey, 2005). The poor sleepers did not overestimate time more in their bedrooms than in the laboratory even when the experiment was posed 30 to 40 minutes prior to their bedtimes (Tang & Harvey, 2005). Tang and Harvey (2005) proposed that the poor time

estimation primarily occurs at bedtime when arousal related to prior poor sleeping experiences increases. They hypothesized that the poor sleepers' inaccurate estimations only occur once they become distressed and aroused at bedtime due to their concerns regarding not being able to sleep (Tang & Harvey, 2005). When these poor sleepers are estimating time that is not related to sleeping, they are able to perform the task easily. It is important to note that the time estimation tests were relatively short (5 seconds, 15 seconds, 35 seconds, 1 minute, and 15 minutes; Tang & Harvey, 2005). It is possible that these time periods were too short to observe inaccurate time estimation by poor sleepers.

Reporting Sleep

Although several studies do not refer to the Harvey model by name, they do reinforce the concept that poor sleepers commonly over-report their wake time. Studies indicate that self-described poor sleepers commonly over-report their perception of wake time in comparison to good sleepers (Carskadon, Dement, Mitler, Guilleminault, Zarcone, & Spiegel, 1976; Borkovec, Lane, & VanOot, 1981). Specifically, insomnia studies have shown that poor sleepers significantly misperceive their length of sleep onset latency and their total sleep time (Means, Edinger, Glenn, & Fins, 2003). In addition, in polysomnography studies, patients misreported being awake during REM sleep and Stage II of NREM sleep (Borkovec et al., 1981; Sewitch, 1984). These studies indicate that poor sleepers for unknown reasons misperceive some aspects of their sleep time as wake time. The Harvey model of insomnia maintenance suggests that higher arousal levels in these poor sleepers promote their misperceptions.

Total Wake Time

This study examines the misperception of a specific sleep variable, total wake time. Total wake time is the total time spent awake in bed from bedtime to final wake up time. Total wake time was chosen in lieu of total sleep time, because wake time during the night is one of the

primary complaints of individuals with poor sleep (Bliwise, 2005; Foley et al., 1995; McCurry et al., 2007; McCurry & Teri, 1995; National Sleep Foundation, 2003; Wilcox & King, 1999). In addition, most sleep misperception researchers examine on how much individuals misperceive the time they spend awake during the night (Borkovec et al., 1981; Means et al., 2003; Sewitch, 1984). By understanding whether individuals misperceive their wake time, future research can focus on treatments for poor sleep that take this information into account.

Sleep and Caregivers

Effect of the Care Recipient on Sleep

Due to the nature of the dementia caregiver role, sleep problems often occur (Creese, Bedard, Brazil, & Chambers, 2008; Teel & Press, 1999; Wilcox & King, 1999). Specifically, dementia caregivers report planned awakenings (i.e. handle medication) and unplanned awakenings throughout the night (i.e. the care recipient wandered outside the home; McCurry et al., 2007). Creese and colleagues (2008) noted that 63% of spousal caregivers reported disturbed sleep due to the nocturnal activity of their dementia patients. This constant awakening throughout the night can lead to poor sleep patterns and compensation techniques, for example, late afternoon napping and caffeine use, which can further hinder sleep (McCurry et al., 2007). One study noted that when respite care became available, the caregivers sleep improved significantly (Lee, Morgan, & Lindsay, 2008). Caregivers reported increased total sleep time, improved sleep quality, and increased time in bed (Lee et al., 2008). Lee and colleagues also noted that when respite care was terminated the caregivers' total sleep time during the night and sleep quality ratings returned to baseline levels (Lee et al., 2008). These data suggest that in some cases of poor sleep in caregivers, the causal factor is the care recipient.

Effect of Psychological Distress on Sleep

In addition to care recipient-induced sleep problems in dementia caregivers, the emotional burden of the caregiving role can negatively impact caregivers' sleep. Dementia caregivers experience a higher prevalence rate of depression and anxiety than noncaregivers (McCurry et al., 2007). Dementia caregivers are also under a significant amount of distress including physical, psychological, emotional, social, and financial (George & Gwyther, 1986; McCurry et al., 2007).

It is for many of these reasons that caregivers often report having difficulty obtaining sleep that is both satisfying and of sufficient duration. Recent studies indicate that 33% of older adult caregivers of dementia patients report sleep disturbances (Creese et al., 2008; McCurry et al., 2007; McCurry & Teri, 1995; Lee et al., 2007; Pruchno & Potashnik, 1989; Wilcox & King, 1999). Several studies have looked at the effects of sleep problems in dementia caregivers (Lee, Morgan, Lindsay, 2007; McKibbin et al., 2005; Teel & Press, 1999). Lee and colleagues noted that dementia caregivers reported higher levels of fatigue than age-matched noncaregivers (2007). McKibbin and colleagues (2005) found that caregivers of patients with Alzheimer's disease had significantly worse sleep than noncaregivers. Specifically, caregivers reported lower total sleep times and significant daytime dysfunction, including daytime sleepiness (McKibbin et al., 2005). It is important to note, however, that these caregivers did not have more nighttime disruptions in comparison to noncaregivers; only fewer hours of sleep (McKibbin et al., 2005). Teel and Press (1999) found that dementia caregivers had more fatigue, less energy, and more sleep difficulties in comparison to noncaregivers. These studies highlight the difficulties dementia caregivers experience regarding sleep.

Effects of Poor Sleep in Caregivers

As addressed, caregivers face numerous difficulties that impede their quality and quantity of sleep. Poor sleep can lead to a multitude of problems including daytime dysfunction (McKibbin et al, 2005) and changes in the caregiver-care recipient relationship. In one study, poor sleep was the primary reason caregivers institutionalized their care recipients (Pollak & Perlick, 1991). Institutionalization can negatively affect the care recipients and their caregivers. Many care recipients find the transition to a nursing home to be very difficult. Some care recipients develop symptoms of anxiety and/or depression with the transition (Blenkner, 1967; Thorson & Davis, 2000). The decision to institutionalize a family member can be very emotional for the caregiver. Many caregivers report increased stress, anger, and depression prior to the placement (Gaugler, Zarit, & Pearlin, 1999). One study showed that husbands who were caring for their spouses reported increased family conflict prior to the placement (Gaugler et al., 1999). Additionally, decreased socioemotional support and family conflict prior to the placement predicted anger and/or depression in the former caregivers (Gaugler et al., 1999).

Sleep Misperception in Caregivers

Although there have been no studies looking specifically at sleep misperception in dementia caregivers, it is possible to make some inferences. Since sleep misperception is based primarily on arousal, dementia caregivers may experience a greater degree of sleep misperception in comparison to noncaregivers. Dementia caregivers report more anxiety and depression than noncaregivers, and therefore may experience more arousal and sleep misperception (Thommessen, Aarsland, Braekhus, Oksengaard, Engedal, & Laake, 2002; Brummett, Babyak, Siegler, Vitaliano, Ballard, Gwyther, et al., 2006). Caregivers frequently report high levels of distressing emotions due to the multiple chores related to caring for their care recipients and the concerns that come along with caregiving (Flaskerund, Carter, & Lee,

2001). This stress is also influenced by the limited amount of social resources and depression that can occur because of limited social relationships and a highly stressful life (Brækhus, Øksengard, Engedal, & Laake, 1998). This chronic anxiety may induce cognitive and physiological arousal during the night, which in turn can create sleep misperception, according to the Harvey model.

In addition to the increased anxiety, dementia caregivers report arousal during the night related to their care recipients' nocturnal awakenings (Creese et al., 2008). Many caregivers have planned awakenings throughout the night in order to manage their care recipients (i.e. handle medication). However, many caregivers also have unplanned awakenings throughout the night, because their care recipients may wander from the house or injure themselves. One may hypothesize that these awakenings may increase the likelihood of sleep misperception, according to the Harvey model. Planned awakenings increase wake time, decrease sleep time, and force the individual to become cognitively and physiologically aroused during the night. This type of arousal does not necessarily contain the level of anxiety that the Harvey model of insomnia maintenance's cognitive and physiological arousal assume; however, this arousal does involve the caregiver becoming cognitively and physiologically more aware than when they were asleep. Unplanned awakenings also increase wake time, decrease sleep time, and create anxiety-related cognitive and physiological arousal. If the care recipient is prone to leaving his bed during the night, it may be hypothesized that the caregiver is hyperaroused and is prone to awakening during the night to check on the care recipient. This uncontrollable and stressful possible event may lead to cognitive and physiological arousal throughout the night, which may be similar in intensity to that anxiety-inducing cognitive and physiological arousal described in the Harvey model of insomnia maintenance.

Due to increased levels of anxiety related to being a caregiver and the multiple arousals during the night related to both planned and unplanned awakenings, dementia caregivers may possibly report higher levels of sleep misperception than noncaregivers. In addition, one may propose that poor sleeping caregivers may misperceive their sleep to a greater extent than do noncaregivers, since their arousal levels and likelihood for sleep misperception may be greater.

CHAPTER 3 STATEMENT OF THE PROBLEM

Evidence suggests that the misperception of wake time during the sleep period is a major contributor to the promotion of poor sleep in individuals. Many researchers have investigated the causal factors of sleep misperception and its relationship with poor sleep (Means & Fins, 1995; Tang & Harvey, 2004). Specifically, the Harvey model of insomnia maintenance suggests that sleep misperception increases the level of arousal in an individual which later leads to chronic poor sleep (Tang & Harvey, 2004). In previous sleep misperception studies, the primary distinguishing variable in participant groups has only been quality of sleep (good versus bad; Borkovec, Lane, & VanOot, 1981; Carskadon, Dement, Mitler, Guilleminault, Zarcone, & Spiegel, 1976). Although these studies have led to a better understanding of sleep misperception, the difference in sleep misperception between caregiving and noncaregiving older adults remains unknown.

This study addresses this question. Better understanding of sleep misperception in both caregiving and noncaregiving older adults is important, because poor sleep is a major concern for both groups (Nau et al., 2005; McCurry et al., 2007; Pollak & Perlick, 1991). In addition, this study endeavors to address the arousal component of the Harvey model of insomnia. Due to dementia caregivers' increase in arousal in comparison to noncaregivers, sleep misperception may play an even greater role in the maintenance of poor sleep in dementia caregivers than it does in noncaregiving older adults (McCurry et al., 2007).

This study investigates the misperception of wake time in three distinct groups of older adults: good sleeping noncaregivers, poor sleeping noncaregivers, and poor sleeping dementia caregivers. Good sleeping dementia caregivers were not studied because there were not enough participants for analysis ($n = 4$). The small number of good sleeping caregivers was due to the

study recruiting caregivers who complained of nighttime activity by their care recipients. This study criterion most likely ruled out most good sleeping caregivers. The noncaregivers and caregivers were divided into good sleeping noncaregiving, poor sleeping noncaregiving, and poor sleeping caregiving groups. This was done to fit with the current sleep misperception literature. Previous research has focused on identifying differences between good sleepers and poor sleepers. Three hypotheses will be tested.

Aim 1

The first aim of this study examines the difference between objective and subjective total wake times within each of the three groups: good sleeping noncaregivers, poor sleeping noncaregivers, and poor sleeping dementia caregivers.

Hypothesis 1

There will be a significant total wake time disparity (subjective versus objective) in the poor sleeping caregiver and the poor sleeping noncaregiver groups. These two groups will have larger subjective total wake times in comparison to their objective total wake times. The significant discrepancy will be found within these two groups, because they maintain a heightened level of disparity-induced arousal.

The poor sleeping noncaregivers will maintain a high level of arousal due to their cognitive and physiological anxiety regarding not sleeping (Tang & Harvey, 2004). The poor sleeping caregivers will maintain their high level of arousal due to multiple factors including (1) cognitive and physiological anxiety regarding not sleeping, (2) cognitive and physiological anxiety regarding whether their care recipients may wander during the night or hurt themselves, and (3) non-anxiety related cognitive and physiological arousal related to scheduled awakenings for nightly chores (Lee et al., 2008; McCurry et al., 2007, Tang & Harvey, 2004). In these two groups, arousal will promote the disparity

between objective and subjective total wake times. Good sleeping noncaregivers will not have a significant discrepancy, because they do not have this chronic arousal.

Aim 2

The first aim examines whether there is an overall discrepancy between subjective and objective total wake times within each of the three groups. Aim 2 assesses the percentage of individuals within each of the three groups who under-estimate, have a consistent estimate, and over-estimate their perceived total wake time (sleep misperception).

Since perfect perception of total wake time is unlikely, a subjective total wake time estimate within 30% of the objective total wake time will be considered consistent. Previous sleep misperception research has only looked at whether individuals over- or under-estimated their perceived wake time or the number of minutes that individuals over- or under-estimated their perceived wake time (Carskadon et al., 1976; Tang & Harvey, 2005). There is no precedent for choosing a margin of error for consistent estimation of sleep misperception. A 10% margin of error would have suggested that individuals who reported 11 minutes of total wake time and objectively had 10 minutes of total wake time were considered over-estimators of their total wake time. A 30% margin of error allows for some discrepancy between the subjective and objective total wake times, without eliminating the possibility of individuals' over- or under-estimating their perception of total wake time.

Hypothesis 2

Poor sleeping caregiving older adults and poor sleeping noncaregiving older adults will over-report their perception of total wake time during the night due to their increased arousal during the sleep period as described in the first aim's hypothesis (Tang & Harvey, 2004). Good sleeping noncaregiving older adults will not exhibit a significant objective/subjective

discrepancy in total wake time, because they do not experience this chronic arousal during the night.

Aim 3

This third aim addresses whether the three groups display significantly different amounts of sleep misperception from one another.

Hypothesis 3

All three groups will have significantly different amounts of sleep misperception from one another. According to the Harvey model of insomnia maintenance (Tang & Harvey, 2004), poor sleep and arousal play a major role in sleep misperception. Poor sleeping caregivers will report the largest amount of sleep misperception. They will report this, because they will experience the following (1) cognitive and physiological anxiety regarding not sleeping, (2) cognitive and physiological anxiety regarding whether their care recipients may wander during the night or hurt themselves, and (3) non-anxiety related cognitive and physiological arousal related to scheduled awakenings for nightly chores (Lee et al., 2008; McCurry et al., 2007, Tang & Harvey, 2004). Poor sleeping noncaregivers will report the second highest amount of sleep misperception, because of their cognitive and physiological anxiety regarding not sleeping (Tang & Harvey, 2004). Since good sleeping noncaregivers do not experience the previously described levels of anxiety and arousal, they will report the least amount of sleep misperception.

CHAPTER 4 METHODS AND MATERIALS

This is a secondary data analysis of two research studies. Both studies collected objective sleep data (actigraphy - two-channel Mini-Meter Actiwatch-L), subjective sleep data (sleep diaries), and demographic information. The first seven days of baseline data from the parent studies were analyzed.

Participants

Noncaregiving Older Adults

The noncaregiving older adults were from a community-based sample study ($N = 103$) recruited from the North Central Florida area. These participants were recruited through media advertisements and community group meetings. Exclusionary criteria included (1) being under the age of 60, (2) having a sleep disorder other than insomnia, (3) having a major psychiatric disorder, (4) having severe cognitive impairment (scoring in the impaired range on 3 or more tests on the Cognistat), and (5) taking psychotropic or other medications that may alter sleep (such as beta-blockers). Subjective (sleep diaries) and objective (actigraphy) sleep data were collected for a two-week period. Only the first seven days of data are reported herein.

Caregiving Older Adults

The caregivers' data was taken from a treatment study ($N = 55$) examining an at home-based monitoring system for informal caregivers of patients with dementia. The system alarms the caregiver if the patient is attempting to exit the house. The caregiving study recruited informal caregivers from the North Central Florida area. The recruitment methods included media advertisements and talks at community group meetings including dementia support groups. Exclusionary criteria included (1) inability to speak and read in English, (2) having a Mini-Mental Status Exam score lower than 27, (3) participating in treatment for a sleep disorder,

(4) not living with his/her care recipient, (5) the care recipient not having a diagnosis of dementia, and (6) the care recipient not engaging in nocturnal activity. Data was collected on the caregivers and their care recipients for a 12-month period. Participants met with the researchers at baseline and then 2-, 3-, 4-, 5-, 6-, 8-, 10-, and 12-months post-baseline. After each interview, subjective and objective sleep data was collected for seven consecutive days. Only the first seven days of baseline data are reported herein.

Measures

Sleep Measures

Total wake time variables were measured concurrently with a subjective measure (sleep diary; Lichstein, Riedel, & Means, 1999) and an objective measure (actigraphy watch; Mini Mitter Co., 2001). Since the total wake time variables were analyzed using both subjective and objective measures, subscripts are utilized to note the type of measure. An “s” subscript denotes the variable was measured subjectively and an “o” subscript denotes the variable was measured objectively.

Subjective sleep measure

This study utilized the daily sleep diary as its subjective sleep measure (Lichstein et al., 1999). Every morning, participants recorded their minutes of napping per day, bedtime, length of time to fall asleep, number of nighttime awakenings, minutes awake during the night, final wake-up time, out-of-bed time, and sleep quality rating. Three subjective sleep variables on the sleep diary were analyzed (1) sleep onset latency (time from lights out until sleep onset; SOL_s), (2) wake after sleep onset (total time spent awake from sleep onset to final wake up time; $WASO_s$), and (3) terminal wakefulness (time spent awake in bed from final wake up time to out of bed time; $TWAK_s$). From these three variables, a total wake time variable (TWT_s) was calculated. Subjective total wake time was defined as the following $TWT_s = SOL_s + WASO_s + TWAK_s$.

Objective sleep measure

This study utilized the two-channel Mini-Meter Actiwatch-L, a wrist-worn actigraphy device, to record objective sleep (Mini Mitter Co. Inc., 2001). Participants wore the Actiwatch-L on their non-dominant wrists for the course of their parent studies. The participants concurrently reported their sleep patterns on their daily sleep diaries, while wearing their actigraphy devices. The Actiwatch-L measures gross motor activity and ambient light exposure and consists of an omnidirectional, piezoelectric accelerometer with a sensitivity of greater than or equal to 0.01 g-force and a light sensor with a recording range of 0.1 to 150,000 lux (Mini Mitter Co. Inc., 2001).

Actiwatch-L analysis was performed using an epoch length of 30 seconds (Lichstein, et al, 2006; Littner et al., 2003). An epoch length of 30 seconds was used, because it matches the 30 second standard utilized for polysomnography scoring (Rechtschaffen & Kales, 1968). During each epoch, the Actiwatch-L samples movement 32 times per second. The highest “activity count” is recorded for each second and the highest activity count within each epoch is used to describe the epoch. This data was downloaded onto a computer and analyzed using the Actiware-Sleep v.3.3 software program. This program uses a validated algorithm to define each epoch as sleep or wake time (Oakley, 1997). Three levels of activity count sensitivity (low, moderate, and high) are available with the Actiware software. A moderate level of sensitivity (40 activity counts) was utilized to define the threshold for wake and sleep. Moderate sensitivity was chosen, because it represents the standard used in sleep research (Morgenthaler et al., 2007). If an epoch’s activity count is equal to or greater than 40, it is scored as wake. If an epoch’s activity count is less than 40, the surrounding 2 minutes (4 epochs) are analyzed using the following equation $\text{Total Activity Epoch } A = E_{A-4} (0.04) + E_{A-3} (0.04) + E_{A-2} (0.20) + E_{A-1} (0.20) + E_A (2) + E_{A+1} (0.20) + E_{A+2} (0.20) + E_{A+3} (0.04) + E_{A+4} (0.04)$. When A is the activity count of a given

epoch, $E_{A+/- (1-4)}$ is the activity count of the four adjacent epochs. If Total Activity Epoch A is less than 40 activity counts, the epoch in question is scored as sleep. Bedtime and final wake up times were determined by the participants' sleep diaries as recommended by the Actiware software. This program defined the start of sleep by the first 10-minute block with one epoch or less of defined wake time. The end of sleep was defined by the first 10-minute block with one epoch or less of defined sleep time.

Four sleep variables were analyzed from the actigraphy data (1) sleep onset latency (interval from subjective bedtime to sleep onset; SOL_o), (2) wake after sleep onset (sum of all wake epochs from sleep onset to wake time; $WASO_o$), and (3) terminal wakefulness (interval from final wake time to out of bed time; $TWAK_o$). From these three sleep variables, a total wake time variable (TWT_o) was calculated. Objective total wake time was defined as the following $TWT_o = SOL_o + WASO_o + TWAK_o$.

Sleep Misperception

Participants' sleep misperception was identified by utilizing both the sleep diary and actigraphy data. The formula to calculate the percentage of sleep misperception (Edinger & Fins, 1995) was defined as follows $\text{Sleep Misperception} = [TWT_s - TWT_o] / TWT_o * 100$.

A sleep misperception score of 0% indicates a perfect match between subjective and objective total wake time. A sleep misperception score of 50% indicates the participant reported on her sleep diary being awake 1.5 times longer than her objective total wake time amount. A sleep misperception score of -50% indicates that the participant reported being awake 1.5 times less than her objective total wake time amount.

Group Classifications

Participants were classified as poor sleepers if they reported 31 minutes or more of unwanted wake time (at sleep onset latency or wake time after sleep onset) for three or more

days of the one week of analyzed data; otherwise, they were classified as good sleepers. A 31 minute criterion was used since it is a more rigorous criterion than the 30 minute criterion, which is common in sleep research (Lichstein, Durrence, Taylor, Bush, & Riedel, 2003).

As previously noted, because only 4 good sleeping caregivers were identified, this group was not analyzed.

Background Information

Demographic (age, gender, education, race, and marital status) and health-related data were collected during the screening and baseline questionnaire process.

Analyses

SPSS 15.0 was used for data analysis. The Kolmogorov-Smirnov and Shapiro-Wilk tests were performed to test for normality. All sleep data variables were significant, indicating that the data was not normally distributed (Table 4-1 for further information). Thus, non-parametric tests were performed to analyze the data. Demographic differences between the 3 sleep groups were analyzed using analyses of variance (ANOVA; age) and Chi-square analyses (gender, race, education, and marital status). Differences between the two poor sleeping groups in regards to subjective total sleep time (TST_s), objective total sleep time (TST_o), subjective total wake time (TWT_s), and objective total wake time (TWT_o) were analyzed using the Mann-Whitney test, the nonparametric version of the Independent Samples t-Test.

For the main analyses of this study, one subjective sleep variable– total wake time (TWT_s), one objective sleep variable– total wake time (TWT_o), and one variable combining both objective and subjective sleep variables– sleep misperception were analyzed. For Aim 1, the Wilcoxon-Signed Ranks test, the non-parametric version of the Paired Samples t-Test, was used to analyze differences in subjective versus objective total wake times within each of the three groups. For Aim 2, the Chi-square was utilized to analyze the percentage of consistent

estimation, over-estimation, and under-estimation of total wake time within each of the three groups. For Aim 3, the Kruskal-Wallis test, the nonparametric version of the ANOVA, was performed to analyze whether the amount of sleep misperception significantly differed between groups. Post hoc analyses were performed using Mann-Whitney tests.

Table 4-1. Normality Test Results

Variable	Kolmogorov- Smirnov	<i>p</i>	Wilk- Shapiro	<i>p</i>
TWT _s ^{a,c}	0.14	0.00	0.89	0.00
TWT _o ^{b,d}	0.14	0.00	0.90	0.00
Sleep Misperception	0.21	0.00	0.76	0.00

^a TWT_s is defined as subjective total wake time.

^b TWT_o is defined as objective total wake time.

^c A subscript “s” denotes the variable was measured subjectively.

^d A subscript “o” denotes the variable was measured objectively.

CHAPTER 5 RESULTS

Demographic, Health, and Sleep-Related Characteristics

The three groups did not differ by age ($F(2, 125) = 69.95, p = 0.24$), gender ($X^2(2) = 4.19, p = 0.12$), marital status ($X^2(4) = 2.08, p = 0.72$), or race ($p = 0.53$). The three groups did differ by education ($X^2(8) = 15.81, p = 0.05$). Specifically, the three groups differed in the number of participants who received graduate education ($F(2, 125) = 3.20, p = 0.04$). There was no difference between the two noncaregiving groups for graduate education, $t(101) = -0.59, p = 0.59$. The good sleeping noncaregivers reported more graduate school work than the poor sleeping caregivers $t(53.01) = 2.71, p = 0.01$. The poor sleeping noncaregivers also reported more graduate school work than the poor sleeping caregivers, $t(52.90) = 2.68, p = 0.01$. To better understand whether health status varied between groups, the number of medications within each group was analyzed. The three groups did not differ by number of medications ($F(2, 125) = 0.54, p = 0.58$). Table 5-1 has additional information on the sample's demographic and health characteristics.

There was a significant difference between the poor sleeping caregivers and the poor sleeping noncaregivers for TST_s ($p = 0.01$) and TWT_o ($p = 0.00$), but not for TST_o ($p = 0.378$) and TWT_s ($p = 0.43$). Good sleeping noncaregivers were not included in this analysis. Since good sleeping noncaregivers report less than 31 minutes or more of unwanted awake time, their sleep variables will be significantly different than the two poor sleeping groups who report at least 31 minutes or more of unwanted awake time. Table 5-2 has additional information on the sample's sleep-related characteristics.

Main Analyses

Aim 1: Differences between Subjective and Objective Total Wake Times within Groups

For good sleeping noncaregivers, TWT_s was significantly larger than TWT_o , $T = 29.00$, $p = 0.00$. For poor sleeping noncaregivers, TWT_s was larger than TWT_o , $T = 0.00$, $p = 0.00$. For poor sleeping caregivers, there was no difference between TWT_s and TWT_o , $T = 3.60$, $p = 0.06$. Table 5-3 has additional information.

Aim 2: Estimation of Perceived Total Wake Time within Groups

The Chi-square was significant for estimations of perceived total wake times within the three groups, $X^2(4) = 22.76$, $p = 0.00$. Specifically, 100% of poor sleeping noncaregivers, 55.90% of good sleeping noncaregivers, and 50.00% of poor sleeping caregivers over-estimated their perception of total wake time. Table 5-4 has additional information.

Aim 3: Differences in the Amount of Sleep Misperception between Groups

The amount of sleep misperception differed significantly by group, $(H(2) = 21.84, p = 0.00)$. Poor sleeping noncaregivers reported more sleep misperception than good sleeping noncaregivers ($U = 490.00, p = 0.00$). Poor sleeping noncaregivers also reported more sleep misperception than poor sleeping caregivers ($U = 65.00, p = 0.00$). There was no difference between good sleeping noncaregivers and poor sleeping caregivers ($U = 406.00, p = 0.99$). Table 5-5 has additional information.

Table 5-1. Demographic Characteristics for the Sample

	Overall Sample (<i>N</i> = 126) <i>M</i>	Noncaregiving		Caregivers
		Good Sleepers	Poor Sleepers	Poor Sleepers
		(<i>n</i> = 32) <i>M</i>	(<i>n</i> = 71) <i>M</i>	(<i>n</i> = 23) <i>M</i>
Age (years)	72.43 (6.97) ^d	73.14 (6.60) ^d	72.38 (7.50) ^d	70.30 (7.18) ^d
<i>Education</i>				
Some High School (%)	4.00	2.80	9.40	0.00
High School Graduate (%)	13.60	9.90	12.50	26.10
Some College/Technical School (%)	28.80	26.80	18.80	47.80
College Graduate (%)	18.40	21.10	15.60	13.00
Graduate School (%)	35.20 ^a	38.00 ^b	43.80 ^c	13.00 ^{b, c}
<i>Race</i>				
White (%)	96.80	94.40	100.00	100.00
Black (%)	2.40	4.20	0.00	0.00
Other (%)	0.80	1.40	0.00	0.00
Female (%)	66.70	59.20	75.00	78.30
<i>Marital Status</i>				
Currently Married (%)	63.50	56.30	65.60	82.60
Previously Married (%)	18.30	16.90	25.00	13.00
Never Married (%)	4.80	5.60	3.10	4.30
Other (%)	13.40	21.2	6.3	0.10
Medications (number)	2.99 (2.18) ^d	3.07 (2.24) ^d	2.66 (2.03) ^d	3.22 (2.24) ^d

^a The three groups differed in graduate education ($F(2, 125) = 3.20, p = 0.04$).

^b There was a significant difference between good sleeping noncaregivers and poor sleeping caregivers, $t(53.01) = 2.71, p = 0.01$. The good sleeping noncaregivers reported more graduate school work than the poor sleeping caregivers.

^c There was a significant difference between poor sleeping noncaregivers and poor sleeping caregivers, $t(52.90) = 2.68, p = 0.10$. The poor sleeping noncaregivers reported more graduate school work than the poor sleeping caregivers.

^d The number within the parenthesis is the standard deviation.

Table 5-2. Sleep Characteristics for the Sample

	Overall Sample	Non- caregivers	Non- caregivers	Caregivers	Z	U	r
		Good Sleepers	Poor Sleepers	Poor Sleepers			
		<i>Mdn</i>	<i>Mdn</i>	<i>Mdn</i>			
<i>Sleep-Related Variables</i>							
TST _s (minutes) ^{b, f}	408.29	414.79	414.79 ^a	374.00	-2.49	222.00 ^a	-0.26
TST _o (minutes) ^{c, g}	425.93	425.21	425.21	420.43	-0.88	230.00	-0.09
TWT _s (minutes) ^{d, f}	70.07	95.71	95.71	126.43	-0.79	220.00	-0.08
TWT _o (minutes) ^{e, g}	42.43	43.29	43.29 ^a	86.07	-5.28	33.00 ^a	-0.54

^a There was a significant difference ($p < 0.01$) between poor sleeping noncaregivers and poor sleeping caregivers.

^b TST_s is defined as subjective total sleep time.

^c TST_o is defined as objective total sleep time.

^d TWT_s is defined as subjective total wake time.

^e TWT_o is defined as objective total wake time.

^f A subscript “s” denotes the variable was measured subjectively.

^g A subscript “o” denotes the variable was measured objectively.

Table 5-3. Results for Aim 1: Differences between Subjective and Objective Total Wake Times within Groups

	<i>Mdn</i> (minutes)		Mean	Mean Positive	<i>Z</i>	<i>r</i>
	TWT _s ^b	TWT _o ^c	Negative Rank Difference	Rank Difference		
Good Sleeping Noncaregivers	50.13	34.57	36.79	29.00 ^a	-3.62	-0.31
Poor Sleeping Noncaregivers	95.71	43.29	16.50	0.00 ^a	-4.94	-0.62
Poor Sleeping Caregivers	126.43	86.07	9.13	3.60	-1.92	-0.38

^a There was a significant within group difference ($p < 0.01$) between TWT_s and TWT_o.

^b TWT_s is defined as subjective total wake time. A subscript “s” denotes the variable was measured subjectively.

^c TWT_o is defined as objective total wake time. A subscript “o” denotes the variable was measured objectively.

Table 5-4. Results for Aim 2: Estimation of Perceived Total Wake Time within Groups

	Noncaregivers		Noncaregivers		Caregivers	
	Good Sleepers		Poor Sleepers		Poor Sleepers	
	Amount	<i>Mdn</i>	Amount	<i>Mdn</i>	Amount	<i>Mdn</i>
Under-Report ^a	16.20%	-49.68%	0.00%	---	8.30%	30.79%
Consistent Report ^b	27.90%	5.80%	0.00%	---	41.70%	14.66%
Over-Report ^c	55.90%	104.85%	100.00%	151.50%	50.00%	92.85%

^a Under-estimation is defined as the self-report of the total wake time being 30% lower than the objective total wake time.

^b Consistent estimation is defined as the self-report of the total wake time being within 30% of the objective total wake time.

^c Over-estimation is defined as the self-report of the total wake time being 30% greater than the objective total wake time.

Table 5-5. Results for Aim 3: Differences in the Amount of Sleep Misperception between Groups

	<i>Mdn</i>	Mean Rank	Difference in Mean Ranks	<i>U</i> Test	<i>Z</i>	<i>r</i>
<i>Post Hoc 1</i>						
Good Sleeping Noncaregivers	36.45%	41.71	27.48	490.00 ^a	-4.42	-0.44
Poor Sleeping Noncaregivers	151.50%	69.19				
<i>Post Hoc 2</i>						
Good Sleeping Noncaregivers	36.45%	40.53	0.20	406.00	-0.03	0.00
Poor Sleeping Caregivers	32.10%	40.33				
<i>Post Hoc 3</i>						
Poor Sleeping Noncaregivers	151.50%	26.47	14.55	65.00 ^a	-3.35	-0.51
Poor Sleeping Caregivers	32.10%	11.92				

^a There was a significant difference ($p < 0.01$) between groups.

CHAPTER 6 DISCUSSION

Discussion of the Findings

Aim 1: Differences between Subjective and Objective Total Wake Times within Groups

This first aim addressed whether there was a significant discrepancy between objective and subjective total wake times within the three groups. Results from this analysis indicate that both good sleeping and poor sleeping noncaregivers exhibit a significant discrepancy between their subjective and objective total wake times. Poor sleeping caregivers did not exhibit a significant difference between their subjective and objective total wake times; however, the group was near significance ($p = 0.06$). This non-significant result may be a result of a small sample size of poor sleeping caregivers ($n = 23$). The hypothesis for this aim was that the two poor sleeping groups would have a significant discrepancy between their objective and subjective total wake times, while the good sleeping group would not. This hypothesis was not fully supported. Specifically, good sleeping noncaregivers reported a significant discrepancy between subjective and objective total wake times and poor sleeping caregivers did not. Poor sleeping noncaregivers reported a significant discrepancy between the variables, as hypothesized.

According to the Harvey model of insomnia, arousal and chronic poor sleep increase the likelihood of misperceiving wake time (Tang & Harvey, 2004). These results indicate, however, that arousal and poor sleep are not the only two factors in significant discrepancies between subjective and objective total wake times. Good sleeping noncaregivers had a significant discrepancy between subjective and objective total wake times although there is no evidence of the cognitive and physiological arousal, which Harvey postulates is necessary for sleep misperception (Tang & Harvey, 2004). These results suggest that discrepancies between subjective and objective total wake times are common to both good sleeping and poor sleeping

groups. The significant results for the two noncaregiving groups and the near significant results for the caregiving group suggest two possible hypotheses. The first is that the discrepancy between subjective and objective total wake times is not necessarily the primary factor in sleep misperception and chronic poor sleep. This hypothesis would suggest that Harvey's theory that sleep misperception is the primary factor in chronic poor sleep is not accurate. Specifically, cognitive and physiological arousal and anxiety may be more important to chronic poor sleep than the sleep misperception this arousal induces. This would explain why three groups have significant or near significant total wake time discrepancies, but not all three groups (good sleeping noncaregivers) report poor sleep. The second hypothesis is that the Harvey model is correct and the discrepancy between subjective and objective total wake time promotes sleep misperception and chronic poor sleep in poor sleepers. This hypothesis suggests that good sleeping noncaregivers are subject to sleep misperception; however, they are more resilient to it and its effects. For example, although the good sleeping noncaregivers report being awake for longer than their objective total wake times, they feel that their sleep is restorative.

Aim 2: Estimation of Perceived Total Wake Time within Groups

While the first aim addressed whether there was a disparity between subjective and objective total wake times within groups, this aim focused on the estimation of perceived total wake times within the three groups. All three groups over-estimated their perception of total wake time. Specifically, 100% of poor sleeping noncaregivers, 55.90% of poor sleeping caregivers, and 50.00% of good sleeping noncaregivers over-estimated their perception of total wake time. The hypothesis for this aim was that both poor sleeping groups would over-estimate their perceptions of wake time, while good sleeping noncaregivers' estimates would be consistent with their objective total wake times. This hypothesis was not fully supported.

The over-estimation of subjective total wake time for the two poor sleeping groups is consistent with previous research (Carskadon et al., 1976; Borkovec et al., 1981). However, good sleeping noncaregivers did not primarily report consistent total wake times as expected (Carskadon et al., 1976; Borkovec et al., 1981). Interestingly, about half of the good sleeping noncaregivers and the poor sleeping caregivers over-estimated their perceived total wake times.

When looking at these first two aims together, these results suggest new information about poor sleeping caregivers. Although there was no significant difference between the subjective and objective total wake times for the poor sleeping caregivers (Aim 1), only half of poor sleeping caregivers over-estimated their subjective total wake times (Carskadon et al., 1976; Borkovec et al., 1981). These results suggest that the Harvey model of insomnia maintenance does not fit with the poor sleeping caregivers' sleep profile. The Harvey model suggests that poor sleepers will overestimate their perceived wake time, since they are both cognitively and physiologically aroused (Tang & Harvey, 2004). According to the literature, poor sleeping caregivers should experience cognitive and physiological arousal related to their poor sleep, cognitive and physiological arousal related to unanticipated awakenings (i.e. the care recipient wanders from the home), cognitive and physiological arousal related to anticipated nightly awakenings (i.e. checking on the care recipient or handling a medication), and a high level of anxiety related to their caregiving duties. According to the Harvey model, this combination of arousal and anxiety should cause most poor sleeping caregivers to misperceive (Tang & Harvey, 2004). In addition, according to the literature, the good sleeping noncaregivers should not experience the arousal and anxiety that is required for over-estimating their total wake times. The only group that continues to fit the Harvey profile for chronic poor sleepers is the poor sleeping noncaregivers. Specifically, this group, according to the literature, experiences cognitive and

physiological arousal related to their poor sleep, which in turn promotes over-estimation of total wake times (Tang & Harvey, 2004). The similar grouping of estimations between poor sleeping caregivers and good sleeping noncaregivers (50.00% versus 55.90%) suggests that sleep misperception may not be the primary factor for chronic poor sleep in these caregivers. In addition, these results suggest that poor sleeping caregivers are more similar to good sleeping noncaregivers than poor sleeping noncaregivers.

Aim 3: Differences in the Amount of Sleep Misperception between Groups

The third aim addressed how the three groups differed in their amount of sleep misperception. There was a significant difference between good sleeping noncaregivers, poor sleeping noncaregivers, and poor sleeping caregivers. Specifically, poor sleeping noncaregivers reported more sleep misperception than both the poor sleeping caregivers and the good sleeping noncaregivers. In addition, there was no significant difference in sleep misperception between poor sleeping caregivers and good sleeping noncaregivers. The hypothesis that poor sleeping caregivers would have the greatest amount of sleep misperception was not supported.

These results further reflect what was found in Aim 2: poor sleeping caregivers are more similar to good sleeping caregivers than poor sleeping noncaregivers. Although the Harvey model suggests that arousal, anxiety, and poor sleep influence the amount of sleep misperception, these data reflect that these factors need to be examined further and that other factors should be considered as well (Means et al., 2003; Tang & Harvey, 2004).

One possible explanation for this phenomenon is that although these poor sleeping caregivers may have the initial high levels of cognitive and physiological arousal and anxiety, they are able to “anchor” their nighttime estimates of wake time. Anchoring might allow the poor sleeping caregivers to make subjective total wake time estimates that match their objective total wake times. One possible anchor which poor sleeping caregivers may use is caring for their care

recipients (Creese, 2008). Many caregivers perform a variety of tasks during the night to maintain their care recipients' health and safety. Although originally hypothesized that this neutral arousal would induce sleep misperception, it is possible that this arousal aids in anchoring perceived total wake time. By anchoring their total wake times to their chores, poor sleeping caregivers are not increasing their arousal, which is required to sustain sleep misperception according to the Harvey model of insomnia maintenance (Creese, 2008; Tang & Harvey, 2004). Caregivers are focusing on their chores and not worrying about being awake during the night. This hypothesis suggests that some of the arousal that the caregivers are experiencing (specifically the cognitively and physiological arousal related to planned awakenings) is not creating anxiety and prompting sleep misperception but instead is helping the caregivers report consistent total wake times.

This hypothesis fits with previous time estimation literature. Tang and Harvey (2005) found that poor sleepers were able to estimate time accurately even in their bedrooms as long as they were not attempting to sleep. These caregivers may be able to accurately estimate their time, because they are focused on a non-sleep activity, for example, checking on their care recipients. Since the caregivers are not actively concerned about not sleeping, when they return to bed, they are able to accurately estimate their wake time. Additionally, the noncaregivers may be estimating poorly because they are estimating their wake times while concentrating on trying to return to sleep. The noncaregivers' focus on trying to return to sleep may hinder their time estimation skills, while the caregivers' focus on non-sleep activities may be helping them estimate their wake time (Tang & Harvey, 2005). This suggests that not all arousal is anxiety-inducing but instead is useful for consistent time estimations.

These data reflect that although dementia caregivers typically experience more distress and anxiety than noncaregivers, they also may experience arousal events that help deter sleep misperception (Brummett et al., 2006; Haape & Berger, 2002; Thommessen et al., & Laake, 2002). Specifically, poor sleeping caregivers had similar over-estimations of perceived total wake time in comparison to good sleeping noncaregivers (Aim 2), and were not significantly different in the amount of sleep misperception in comparison to good sleeping noncaregivers (Aim 3). In contrast to the Tang and Harvey study (2004), these results suggest that sleep misperception does not automatically occur because individuals are aroused and anxious during the night. Instead, it is possible that some types of arousal (planned nighttime activity) may help individuals estimate wake time and not misperceive wake time. These results also suggest that poor sleeping caregivers are more similar to good sleeping noncaregivers than to other poor sleeping groups (i.e. noncaregivers). Specifically, although poor sleeping caregivers and good sleeping noncaregivers may use different resources and techniques (for example, planned-awakening arousal versus limited awakenings) to limit the amount of sleep misperception they experience, they are both able to do so more effectively than poor sleeping noncaregivers.

Limitations

This study has several limitations. First, two research studies were combined to create this study. The caregivers and the noncaregivers fulfilled two different sets of rule out criteria. Although the criteria were very similar, there is the possibility that a single rule out criteria would have elicited different participants. Second, this was a secondary data analysis. Only measures that were administered for the a priori hypotheses of the two respective studies could be analyzed to understand sleep misperception. Additional measures may have been used to further understand sleep misperception in caregiving and noncaregiving older adults. Third, a selection bias for poor sleep in the caregivers may have occurred. Caregivers joined the study

because their care recipients experienced awakenings during the night. It is possible that caregivers whose care recipients do not awaken during the night, and therefore did not join the study, have good sleep. It is for this reason that there may have been a limited number of good sleeping caregivers recruited ($n = 4$). Fourth, both studies primarily enrolled Caucasian, female participants. The female gender is representative of the caregiving community; however, the caregiving community is ethnically diverse. These results may not necessarily be generalized to the larger dementia caregiving community. Fifth, this study only examined caregivers of dementia patients. These results may not generalize to the greater caregiving community. Sixth, as noted earlier, poor sleep and health problems are interrelated. Although there was no difference between groups for the number of medications used, it is possible that the health status of the groups contributed to the results of this study.

Future Directions

This study suggests two interesting venues for future research. First, this study was unable to analyze good sleeping caregivers due to the small number ($n = 4$). Future studies should attempt to actively recruit good sleeping caregivers to determine if they exist. If they do, research regarding their ability to accurately perceive their sleep and wake time should be investigated.

Second, the results of this study suggest that caregivers are able to anchor their estimates of wake time, possibly with the use of nighttime caregiving duties. However, it is unknown whether poor sleeping caregivers (and caregivers in general) are able to estimate accurately all wake time episodes. It is possible that caregivers may experience two difference types of nighttime awakenings: anchored awakenings and non-anchored awakenings. The non-anchored awakenings involve the cognitive and physiological arousal that Harvey describes as inducing anxiety-related sleep misperception. The anchored awakenings also involve cognitive and physiological arousal; however, this arousal is not anxiety-inducing but instead promotes

consistent estimation. This “anchored” arousal may be similar to “normal day arousal” and therefore the individual is able to estimate time as accurately during those episodes as during the day. Future research should examine whether caregivers are able to accurately estimate their sleep onset latencies, wake after sleep onset periods, and terminal wakefulness. It is possible that caregivers are able to accurately estimate certain periods of the night better than others. For example, nighttime awakenings may be anchored to chores. At the same time, caregivers may misperceive wake time when trying to fall asleep, because the caregivers may be more focused on trying to sleep than caregiving duties (and other time anchoring activities).

This investigation of how sleep misperception may vary at sleep onset, during the night, and at final wake up time may also play a major role in future research for sleep treatment plans. Current treatments for insomnia focus on eliminating most wake time during the night. Many caregivers, unfortunately, cannot remove all nighttime wakefulness because of required caregiving duties and unexpected nocturnal care recipient activity. By better understanding if and when caregivers misperceive their sleep, clinicians can focus on limiting that misperception. In addition, future research needs to examine if and when caregivers experience cognitive and physiological arousal and anxiety that induces sleep misperception, as per the Harvey model. For example, if caregivers experience anxiety-inducing arousal at sleep onset only, clinicians can focus their efforts on that portion of the night. Also, if research indicates that caregivers experience anchoring-induced arousal during their wake after sleep onset period, clinicians may be able to focus their treatment efforts on other ways of increasing sleep quality. Future research should focus on if and when caregivers accurately perceive their wake time and misperceive their wake time to better serve this group in a treatment environment. With additional research in this area, clinicians will be able to tailor insomnia treatments for caregivers to their specific needs.

Summary

This study suggests that poor sleeping caregivers are similar to good sleeping noncaregivers. Specifically, there was a significant difference between subjective and objective total wake times in the good sleeping and poor sleeping noncaregiving groups. There was no difference between subjective and objective total wake times in the poor sleeping caregivers; however, the group almost reached significance ($p = 0.06$). This group may have had a significant discrepancy if the sample size had been larger ($n = 23$). Both good sleeping noncaregivers and poor sleeping caregivers reported similar estimates of perceived total wake times. There was a significant difference in sleep misperception between groups. Poor sleeping noncaregivers reported a significantly larger percentage of sleep misperception compared to both good sleeping noncaregivers and poor sleeping caregivers. In addition, there was no significant difference in the percentage of sleep misperception between good sleeping noncaregivers and poor sleeping caregivers. These results suggest that poor sleeping caregivers are able to estimate total wake time as accurately as good sleeping caregivers. This result is in conflict with the Harvey model of insomnia maintenance, which links the maintenance of poor sleep with sleep misperception. One possibility for the poor sleeping caregivers being able to accurately estimate their total wake times is that some of their arousal during the night does not promote sleep misperception as per the Harvey model. Instead, this arousal (from planned nightly chores) anchors their wake time. Future research studies looking at sleep onset, wake episodes after sleep onset, and wake time prior to exiting bed is warranted. By engaging in research at these specific time points, researchers may be able to better understand when dementia caregivers are misperceiving wake time and when they are not.

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BIOGRAPHICAL SKETCH

Pamela Dubyak's interest in sleep research began when she was a junior at Brown University. She became engaged in the literature once she discovered that although people spend one-third of their lives sleeping, no one understands fully why people sleep. During the summer of 2003, Ms. Dubyak had the opportunity to work with Dr. Mary Carskadon and learn more about her research in development and sleep. After graduating from Brown with a Bachelor of Arts in American civilization and psychology, Ms. Dubyak took a break from sleep research. She worked for two years at the Substance Abuse Research Unit at Rhode Island Hospital. She presented a poster at the Association of Behavioral and Cognitive Therapies national convention on research on the relationship among Hepatitis C, health beliefs, and risk behaviors in a substance-using population. In 2006, she returned to academia and sleep research. For the past two years, she has worked in the Sleep Research Laboratory under the supervision of mentor Dr. Christina McCrae in the Department of Clinical and Health Psychology at the University of Florida. During her time at the University of Florida, she has presented some of her research on objective and subjective differences between caregiving and noncaregiving older adults at the annual Sleep Conference. Although her interests within the field of sleep have varied, she continues to be drawn to understanding how sleep plays an important role in people's lives.