Holiday and School Term Sleep Patterns of Australian Adolescents

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DECLARATION

I declare that this dissertation is my own account of my research and does not contain any work that has been previously submitted for a degree at any institution, except where due reference has been made. The ethical principles for research as stipulated by the Australian Psychological Society and Swinburne University of Technology have been adhered to in this research.

Signed:

Suzanne Warner

March, 2006
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ABSTRACT

Previous research has established that school aged adolescents generally do not obtain enough sleep for their developmental needs. A combination of later and later bedtimes along with wake times that remain constant due to school commitments contributes to this. However, when adolescents have the opportunity, such as during holidays, they tend to sleep for longer and to prefer late bed and wake times. Consequently, teenagers have been described as becoming more “evening typed,” that is, preferring evening activities, and demonstrating a later sleep/wake phase. Besides increased social factors that impact on adolescents’ opportunity for sleep, there is evidence that biological changes during puberty also affect the later timing of sleep. Many adolescents also report poor sleep quality. The consequences of insufficient sleep have been linked with poorer daytime functioning, lower mood, and lower grades.

Despite this overall trend for adolescents in general to become more “evening typed”, research suggests that there are still individual differences in adolescents’ preferences for the timing of daily activities and sleep that can be measured by morningness-eveningness scales. Evidence suggests that these preferences are linked to physiological processes within the body that are associated with circadian timing. It has been suggested that adolescents with more of an evening preference are more vulnerable to poorer outcomes in terms of mood, performance, and academic achievement during the school term due to the difficulties they face in scheduling and initiating sleep. This proposed pathway provided the theoretical model on which the present study was based.

The current project examined the differences between holiday and school sleep patterns, as well as investigating the complex interrelationships between sleep patterns, sleep quality, circadian preference, substance use, mood, daytime functioning, and grades in a longitudinal study. Three hundred and ten senior students from three secondary schools in metropolitan Melbourne completed both holiday and school time self-report surveys. The aims of the study were to provide information on the sleep patterns of Australian adolescents; to compare sleep patterns at holiday and school time; to ascertain the impact of school term on sleep patterns, mood, and performance; and to investigate whether individual circadian preference played a mediating role in any observed changes.
Consistent with reported trends, evidence was found that students tended to adopt a later sleep/wake phase over the holidays, with the majority satisfied with the amount of sleep they obtained. At school time, students obtained about 1 hour, 17 minutes less sleep on week nights than they did over the holidays, and needed to wake up about 2 hours, 30 minutes earlier than their preferred holiday wake time in order to get ready for school. Mood and daytime functioning were significantly worse during school term and were associated with lower sleep times, poorer sleep quality, higher substance use, an evening preference, and female gender. Higher sleep debt along with later bedtimes were also associated with poorer daytime functioning. Sleep quality was found to be a more important predictor of these outcomes than sleep duration. Later bedtimes and wake times, an evening preference, higher substance use, male gender and sleep irregularity were associated with lower self-reported grades.

Individual preference for morningness or eveningness significantly impacted on sleep duration and sleep debt, over and above the impact on the sample as a whole due to the imposition of school schedule. An evening preference was associated with shorter sleep times and higher sleep debt at school time. Furthermore, support was found for the hypothesis that circadian preference mediates mood, daytime functioning and self-reported grades through its effect on sleep variables at school time.

The study demonstrated that sleep patterns and circadian factors significantly affected the day-to-day functioning, well-being, and academic achievement of adolescents. The importance of sleep in the daily lives of adolescents is discussed, and an argument is made for increased understanding in educational, clinical, and family settings of the developmental sleep needs of this age group. Areas to be clarified and explored further are identified for subsequent research.
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1.1 Purpose of the Current Project

With the hectic pace of our achievement-oriented life, sleep has often been regarded as an indulgence, or optional activity, with increasing work hours and leisure activities replacing time for sleep. Research into adolescent sleep habits suggests that young people accumulate considerable sleep debt due to their busy schedules, and that this has serious effects on their well-being and ability to cope with school and life (Wolfson & Carskadon, 1998). While school start and finish times remain consistent, homework expectations increase, and teenagers have the opportunity to also work at part-time jobs, and be involved in sporting and extra curricular activities. In addition to this, adolescents enjoy increased freedom to interact socially, and the ever-expanding availability of leisure activities based around television, videos, mobile phones, computer games, internet use and music, creates competition for time, with the implication that sleep is sacrificed (Carskadon, 1999).

Longitudinal studies have shown that as children progress through adolescence they obtain less sleep due to later and later bedtimes, with the tendency for their wake times during the week to remain constant due to school start times. The gap between sleep duration on the weekend and during the school week tends to widen during adolescence, with the inference that teenagers try to catch up on sleep debt on the weekends, and generally do not get enough sleep because of their busy schedules (Hansen, Janssen, Schiff, Zee, & Dubicovich, 2005; Iglowstein, Jenni, Molinari, & Largo, 2003; Laberge, Petit, Simard, Vitaro, & Tremblay, 2001; Wolfson & Carskadon, 1998).

Research also points to biological changes that occur at puberty that influence the later timing of sleep in adolescence (Carskadon, Veira, & Acebo, 1993; Carskadon & Acebo, 1997). It is argued that these changes are instrumental in teenage behaviour that is noticed and puzzled over by their parents. Where once their child was awake and alert first thing in the morning without any prompting from parents, at around puberty it can become a difficult undertaking to get a teenager out of bed. Coupled with this is the observation by many parents that their teenager, despite being sleepy for much of the
day, becomes alert at night and unwilling to go to bed. Researchers have commented on this and described it as teenagers becoming more “evening typed”, that is, preferring later bedtimes, and also later wake times when they have the opportunity. This sleep pattern has been observed on weekends, and also in a few studies that have compared holiday with school term sleep patterns. It has been proposed that holidays represent the natural rhythm and preference of adolescents in terms of their sleep patterns (Hansen et al., 2005; Palazzo, Piala, Camoin, & Rey, 2000).

However, apart from this overall general trend for adolescents to become more “evening typed”, there are still individual differences in preference for the timing of daily activities (morningness-eveningness) exhibited in this age-group, as is apparent throughout the lifespan (Roenneberg et al., 2004). This preference is thought to be trait-like, that is, to be fairly stable over time, with implications for a person’s ability to perform at their best at particular times of the day. Evening types prefer a later sleep/wake cycle, and tend to be at their best in the evening, thus delaying bedtimes, whereas morning types prefer an earlier sleep/wake cycle, tending to be alert and able to perform optimally in the morning (Horne & Ostberg, 1976: Monk, Buysse, Potts, De Grazia, & Kupfer, 2004). Consequently, school students with an evening preference are at risk of being even more “out of kilter” with the arrangement and demands of the school day, unless they can adapt and change their natural sleep/wake cycle. For adolescents who must get up early for school, delaying bedtimes severely impacts the amount of sleep it is possible to obtain.

Studies on the sleep habits of adolescents note that young people are often dissatisfied with the amount of sleep that they obtain, and sleep for less time than is thought necessary for them to perform optimally during the day (Strauch & Meier, 1988; Wolfson & Carskadon, 1998). In addition, a significant proportion of adolescents complain of sleep difficulties that might impact on the amount of sleep they obtain (Bearpark & Michie, 1987; Dahl & Lewin, 2002). Lower sleep times have been associated with lowered mood, sleepiness, poorer functioning during the day, increased accidents, increased substance use, and poorer academic grades (Gianotti, Cortesi, Sebastiani, & Ottavio, 2002; Wolfson & Carskadon, 1998).
Where once it was accepted that an individual’s need for sleep decreased with age, with adolescents seen as being part of that continuum, investigation into sleep habits suggests that adolescents still need as much sleep as they did when they were children, and that insufficient sleep may be impacting negatively on their ability to function adequately during the day and to concentrate and learn. Some authors have even suggested that the increases that have been noted in adolescent depression may be linked to this lack of sleep, with many of the symptoms of depression mimicking those of sleep deprivation (Dahl & Lewin, 2002; Wolfson & Carskadon, 1998).

Associations between sleep patterns, circadian preference, lowered mood, daytime functioning, and grades, have been noted in research (Gianotti et al., 2002). In three studies from Poland, France, and the US comparing holiday and school sleep times, it has been shown that the impact of school schedule negatively impacts on the sleep duration of adolescents (Hansen et al., 2005; Palazzo et al., 2000; Szymczak et al., 1993). However, it is not known whether, with the imposition of school schedule, there is also a detrimental effect on mood and daytime functioning as compared to holiday time. The issue of causality regarding sleep habits and mood and functioning has also not been explored in this age group, and neither has the possibility that individual circadian preference may impact negatively on sleep duration, mood, daytime functioning and grades over and above the imposition of school schedule.

To date, little work that is comparable with overseas research has been carried out in the Australian adolescent context. The purpose of the current study was therefore firstly to provide some more detailed descriptive information than has been provided so far on the sleep habits of Australian senior school students. Secondly, this study aimed to further knowledge about how sleep habits influence mood and daytime performance by attempting to model the causal links between these factors at both holiday time and school time. A further objective was to ascertain the impact of school scheduling on sleep habits, mood, and performance factors, and to explore whether individual circadian preference plays a mediating role in regards to these factors. To achieve these objectives a longitudinal study was conducted with senior school students in Victoria, Australia. Information was collected at two time points over the school year by way of self-report surveys. The first survey asked about holiday sleep patterns and the outcomes of mood and performance, and the second survey was completed by the
same students later in the year, during school term, asking about sleep patterns, mood and performance during school time.

1.2 Arrangement of the Thesis

Firstly, a review of the relevant literature is presented over several chapters. Chapter Two outlines the studies that have been conducted in other countries, giving an overview of sleep habits and general trends that have been reported in the research. The results of an experimental study that supports the view that adolescents do not have decreased sleep need is also presented in this chapter. In Chapter Three literature concerning adolescent sleep quality and sleep difficulties is reviewed, with prevalence rates for sleep difficulties for Australia and other countries noted, and research presented that links sleep difficulties with psychiatric disorders. Chapter Four presents the biological factors that are hypothesised to affect adolescent sleep patterns, including circadian rhythms, the role of melatonin, and individual preference for circadian phase (morningness-eveningness). Following this, the external factors that affect adolescent sleep patterns are discussed in Chapter Five, and include issues such as cultural differences, parental control, part-time work, homework, social activities, and school start times. Next, Chapter Six addresses the consequences of insufficient sleep and poor quality sleep for adolescents, outlining findings from both experimental and naturalistic school-based studies that have demonstrated a range of negative day-to-day functioning problems for this group. On the basis of the literature presented, Chapter Seven provides a rationale and detailed aims for the present study, also presenting specific hypotheses. Chapter Eight presents the study method, providing information on the participants, survey measures used, procedures for collecting and processing the data, and an overview of the statistical treatment. The results of the study are found in Chapter Nine. Finally, Chapter Ten discusses the findings of the current study and how these relate to previous work from other countries. Implications of the findings are discussed, along with limitations of the study, and areas that could be further validated and explored.
Chapter Two: Adolescent Sleep Habits

2.1 Overview

In this second chapter, the literature on adolescent sleep habit studies is reviewed. These studies have surveyed teenagers, and sometimes their parents, about sleep patterns during the school week and on weekends. The studies have used mostly retrospective survey data, asking participants to note their usual sleep patterns. There are also a small number of studies that have contrasted holiday and school term sleep habits, and some reports of gender differences in sleep habits. At the conclusion of the chapter the findings about sleep habits during the week, weekend, and holidays are integrated to present a general view of adolescent sleep patterns.

2.2 Sleep Habits during the School Week

It has long been assumed that less sleep is required as people age, and adolescents were thought to need less sleep than younger children. Studies supporting this presumed developmental trend, such as one by Terman and Hocking (1913), observed decreased sleep times for each older age group in their sample of six year olds to 20-year-olds in the US. Sleep duration times decreased from over 11 hours for the youngest group, down to less than 8 hours sleep for the oldest group in the study, prompting these authors to dismiss the accepted norm at the time that adolescents required about 9 hours of sleep per night as “misleading and worthless” (Terman & Hocking, p. 147).

More recently this trend of decreasing sleep duration with age has been confirmed in countries such as Canada, France, Italy, Korea, Japan, Poland, Switzerland and the US, with results suggesting that shorter sleep times are related to later bedtimes as children grow older (Arakawa et al., 2001; Fakuda & Ishihara, 2001; Gau & Soong, 1995; Gianotti, Cortesi, Sebastiani & Ottaviano, 2002; Iglowstein, Jenni, Moliani, & Largo, 2003; Laberge, Petit, Simard, Vitaro, Tremblay, & Montplaisir, 2001; Levy, Gray-Donald, Leech, Zvagulis, & Pless, 1986; Palazzolo, Piala, Camoin, & Rey, 2000; Strauch & Meier, 1988; Szymczak, Jasinka, Pawlak, & Zwierzykowska, 1993; Tagaya et al., 2004; Yang, Kim, Patel, & Lee, 2005). Studies have also reported that adolescents tend to become sleepier during the day as they progress through puberty (Carskadon, Orav, & Dement, 1983; Fukuda & Ishihara, 2001; Mantz, Muzet, &
While this developmental trend has been consistently described in research, reported sleep duration times vary. In their longitudinal study of over 1,000 Canadian children tracking sleep patterns from age 10 to 13 years of age, Laberge et al. (2001) found that sleep duration on school nights decreased from 10 hours, 30 minutes\(^1\) at 10 years of age, down to 9 hours, 25 minutes at 13 years, a decrease of 63 minutes. Iglowstein et al. (2003) reported on sleep-related questionnaires from the Zurich Longitudinal Studies that tracked babies from one month old until they reached 16 years of age, by surveying their parents. Average sleep times of 9 hours, 54 minutes for 10 year olds decreasing to 8 hours, 42 minutes for 14 year olds were reported. Similarly Szymczak et al. (1993) noted 10 hours, 12 minutes for 10-year-olds and 8 hours, 42 minutes for 14-year-olds, in their study that followed 40 Polish children over the course of one year.

For older adolescents the trend was found to continue. Iglowstein et al.’s (2003) Zurich Longitudinal study reports that sleep duration decreased still further down to 8 hours, 6 minutes at 16 years, while Wolfson and Carskadon (1998) reported a decrease from 7 hours, 42 minutes for 13 to 14-year olds, down to 7 hours, 6 minutes for 17 to 19 year olds on school nights in the US, a decrease of approximately 40 minutes across the four different age groups in the sample. This finding was confirmed by Hansen et al., (2005) who also found sleep duration of approximately 7 hours on school nights for American senior school students. Notably, there was little variability in wake-up times, indicating the synchronising effect of school start times, which are around 7:30 a.m.\(^2\) for this age group in the US. This synchronising effect of school starting time has been noted in other studies observing a much smaller standard deviation for school day wake up than for bed times or weekend patterns (Andrade, Benedito-Silva, Domenice, Arnhold, & Menna-Barreto, 1993; Lee, McEnany, & Weekes, 1999; Wolfson & Carskadon, 1998; Yang et al., 1999).

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\(^1\) Studies have varied in the method of reporting time. Some use decimal representations, others hours and minutes. For the purpose of this thesis, all time is reported consistently throughout in hours and minutes.

\(^2\) Clock time is reported variously in studies in either 24 hr. or 12 hr. format. For ease of interpretation, clock time is presented in 12 hr. format throughout the thesis, except in the results section where statistical software necessitated data to be entered and analysed in a 24 hr. format.
Senior high school students in Wolfson and Carskadon’s (1998) US sample went to bed, on average, at around 10:51 p.m. on school nights, waking at about 6:10 a.m. to accommodate an early school start. In Italy, adolescents of a comparable age group tended to go to bed at around 11:15 p.m. and wake at 7:05 a.m., obtaining about 7 hours, 40 minutes sleep on school nights (Gianotti, Cortesi, Sebastiani, & Vagnoni, 2005). Ohayon, Roberts, Zulley, Smirne, & Priest (2000) reported in their study of 1,124 adolescents aged 15 to 18 years in Great Britain, Germany, Italy and France that these European students obtained about 7 hours, 54 minutes sleep on school nights, tending to go to bed earlier (around 10:36 p.m.) and wake later (about 7:07 a.m.) than their counterparts in the US.

The discrepancy in sleep duration times reported between European countries and those of the US might be accounted for by different school start times, and possibly differences in the amount of control that parents exert over bedtimes (Tynjala, Kannas, & Villberg, 1999). Differences in methodology may also account for some of the variance in reported sleep duration, with two of the studies based on maternal report (Iglowstein, 2003; Laberge et al., 2001), and the remainder based on school-based questionnaires filled out by the students themselves. While parents might be able to report on the time an adolescent supposedly goes to bed, it is unlikely that they are able to accurately report if their child actually goes to sleep at this time.

In contrast to these times reported in Europe and North America, shorter sleep times have been found in studies in Asia. Research conducted with 1,650 school children in Japan showed that children in the elementary grades (average 10 years) slept for approximately 9 hours, decreasing to 7 hours, 38 minutes in junior high (average 13 years) and 6 hours, 58 minutes in senior high (average 16 years) (Takemura et al., 2002). Cultural differences, as well as the propensity for Japanese students to nap in the early evening have been forwarded as possible reasons for the comparatively lower nocturnal sleep times in this country (Tagaya et al., 2004). Research conducted by Fukuda and Ishihara (2002) with a sample of 10,000 high school students showed that over half of these Japanese students took early evening naps, and that this was strongly related to later bedtimes and shorter nocturnal sleep times.
Even shorter sleep times have been reported for Korea and Taiwan. A cross-sectional study of 1,457 elementary and high school students in Korea found that weekday sleep times decreased by about 3 hours from grade 5 to grade 12. The grade 5 to 6 children (average 11 years) obtained 8 hours, 18 minutes of sleep on school nights, decreasing to 7 hours, 36 minutes per night in grades 7 to 8 (average 13 years). In grades 9 to 10 (average 15 years), school night sleep times decreased to 6 hours, 36 minutes which further decreased to just 5 hours, 24 minutes in years 11 to 12 (average 17 years) (Yang et al., 2005). In a similar study, it was reported that Taiwanese junior high school students obtained an average of 6 hours, 54 minutes sleep on school nights, going to bed at, on average, about 11:12 p.m. and waking for school at about 6:11 a.m., with a 2-hour sleep in at weekends. These researchers suggested that the discrepancies between their findings and those of other countries were due to the intense academic pressure of completing homework, and in the case of the Korean students, also attending night school (Gau & Soong, 1995; Yang et al., 2005). This factor may be reflected in the late bedtimes reported in Yang et al.’s study, with junior school students going to bed at approximately 11:12 p.m., middle school students at midnight, and senior school students at approximately 12:54 a.m.

Of interest is the finding that not only is there a trend of decreasing sleep times as children progress through adolescence, but there is also evidence of generational trends in decreasing sleep times. Iglowstein et al. (2003) reported that the cohorts in their longitudinal study from 1974 to 1993, showed increasingly later bedtimes but consistent wake times over the course of the study. This resulted in increasingly shorter sleep times over the decades. For example, for 14 year olds the mean nightly sleep time decreased from 9 hours in 1974 down to 8 hours, 48 minutes in 1986 across cohorts. These researchers suggest that possibly parents have become more permissive and less involved in setting children’s bedtimes, and that this may account for the difference over time.

It is notable that, apart from a study by Lack (1986) reporting on sleep habits of students at an Australian university, there are no studies of sleep patterns of Australian adolescents, and none that document the sleep habits of senior secondary students.
2.3 Weekend Sleep Habits

Another consistent finding in the literature is that weekday and weekend sleep schedules become distinctly different with age and pubertal status. While research with prepubertal children generally indicates a small difference between weekday and weekend sleep habits (Laberge et al., 2001; Takemura et al., 2002; Yang et al., 2005), weekend bedtimes become increasingly later than school night bedtimes as children progress through adolescence, with later wake-up times and longer sleep times on the weekend (Andrade et al., 1993; Gianotti et al., 2002; Laberge et al., 2001; Lee et al., 1999; Mercer, Merrit, & Cowell, 1998; Szymczak et al., 1993; Wolfson & Carskadon, 1998; Yang et al., 2005).

However, although adolescents tend to have longer sleep duration on the weekends than on school nights, the trend for decreasing sleep as they grow older has been apparent on weekends also, although less pronounced than decreases in weekday sleep duration. (Andrade et al., 1993; Laberge et al., 2001; Strauch & Meier, 1988; Szymczak et al., 1993; Takemura et al., 2002; Wolfson & Carskadon, 1998; Yang et al., 2005). Wolfson and Carskadon (1998) reported a decrease in weekend sleep duration of approximately 50 minutes across the age groups in their study (13 – 19 years), while the weekend bedtimes became increasingly later by about one hour. They noted that weekend wake-up times did not differ significantly with age.

It has been suggested also that the irregularity that is shown by adolescents in regard to the later bed and wake times over the weekend tends to maintain or exacerbate the inclination for delayed sleep phase. Sleeping in on the weekends, while being an opportunity to pay back sleep debt from the school week, tends to delay bedtime even further, so by Sunday evening, it might be difficult to get off to sleep at an earlier time in order to accommodate school the next day (Dahl & Caskadon, 1995; Sorenson & Ursin, 2001).

2.4 Holiday Sleep Habits

A few studies have compared holiday and school term sleep habits (Hansen et al., 2005; Palazzolo et al., 2000; Szymczak et al., 1993). In Poland, Szymczak et al. (1993) compared holiday and school sleep habits in 64 children aged 10 and 14 years, concluding that children sleep for significantly longer during holidays than they do
during school term, largely due to later wake-up times. They observed larger variability in wake-up times in holidays than school days. During school term, both groups of children slept longer on the weekends, but this difference was not observed during holidays, with the children tending to maintain more consistent bedtimes, wake times and sleep times across the week. They concluded that school start times served as a social synchroniser during term, as evidenced by the small variability in wake-up times on school mornings, and that the children were partially sleep deprived during school, resulting in recovery sleep on weekends.

Investigating holiday and school term patterns in an older age group (15 – 20 years) in France, Palazzo et al. (2000) observed a similar trend to that reported by Symczak et al. (1993). They noted that sleep duration for holidays and school term weekends were similar, with students getting about 2 hours less sleep on school nights. They suggested that holiday sleep patterns were the natural preference for these young people in their sample, reporting that 15-year-olds slept on average for 9 hours, 40 minutes on holidays, decreasing to 8 hours, 30 minutes for 20-year-olds.

In a recent study in the US, Hansen et al. (2005) investigated the impact of school schedule on the sleep of 60 high school students who kept sleep wake diaries over their summer holidays and for the first two weeks of school term. Once again, similar patterns were seen, with students losing up to 2 hours of sleep per weeknight when school started. The mean sleep duration was 8 hours, 42 minutes during the week at holiday time compared to a mean of 7 hours sleep on school nights during term. Weekend sleep was also observed to be longer during school term (approximately 30 minutes) than during the holidays, suggesting a “catch up” on sleep. However, Hansen et al. also observed that the school term weekend sleep times were similar to weeknight holiday sleep duration and suggested that school term weekend sleep may be a reflection of the adolescents returning to their natural sleep patterns when free of the constraints of school schedule. These studies suggest the nature of adolescent sleep patterns are compromised with the imposition of the school schedule, also implying that holiday time could be a useful time to conduct research about preferred sleep patterns.
2.5 Gender Differences in Sleep Habits

There have been mixed findings in regard to gender differences in adolescent sleep habits. Some studies have reported that girls tended to get up earlier on school mornings, but otherwise sleep patterns and sleep duration of boys and girls were similar (Lee et al., 1999; Wolfson & Carskadon, 1998). This school day pattern was also observed by Yang et al. (2005) in Korea, who proposed that perhaps girls needed more time to get ready for school or to attend to chores. However, the girls in their study tended to sleep longer on weekends than the boys, a finding also compatible with a study of young adolescents (Laberge et al., 2005). Yang et al. inferred that this shift in sleep patterns indicated that the girls were more sleep deprived than the boys during the week and needed to catch up on weekends. In studies of 3,833 Japanese students, (Tagaya et al., 2004) and 1,572 students in Taipei (Gau & Soong, 1995) it was found that girls tended to get up earlier, but also that they had shorter sleep times than boys. Gianotti et al. (2002) reported that girls had earlier wake times than boys at both weekday and weekends in their large sample of Italian adolescents aged 14 to 18 years old. The boys had shorter sleep times on the weekends than the girls. From this research it seems that girls may get up a little earlier than boys during the school week, but that there is no consistent evidence to date to suggest that there are other robust gender differences in sleep times or patterns of adolescents.

2.6 Adolescent Sleep Need

In surveys, adolescents have consistently stated that they would like more sleep than they obtain (Gau & Soong, 1995; Mercer et al., 1998; Morrison, McGee, & Stanton, 1992; Strauch & Meier, 1988; Takemura et al., 2002; Wolfson & Carskadon, 1998; Yamaguchi, Kawamura, & Maeda, 2000). Some studies have included a self-reported sleep need, where participants were asked to report how many hours of sleep they required to feel at their best. In line with the patterns of actual sleep times observed in different countries, a similar pattern emerged in reported sleep need, with participants in Asia reporting that their sleep need was much lower than those reported in Europe and the US. For example, Gianotti et al.’s (2002) 14 to 16 year olds in Italy thought that 9 hours, 32 minutes was ideal for them, with 9 hours, 6 minutes required on average for the 16 to 18 year olds. Reported sleep need in Wolfson and Carskadon’s (1998) US study for 13 to 19 year olds was an average of 9 hours. In comparison to this, in Korea, 12th grade students thought that about 7 hours, 5 minutes was enough for them.
(Yang et al., 2005), while in Japan junior high students reported about 8 hours, 54 minutes sleep need, and high school students 8 hours, 24 minutes (Takemura et al., 2002). Once again, cultural differences in the habit of napping after school in some Asian countries may account for the difference in sleep need that has been articulated in these two studies.

In a longitudinal study of six years, Carskadon and colleagues sought to investigate the sleep needs of adolescents (Carskadon, Harvey, Duke, Anders, Litt, & Dement, 1980; Carskadon et al., 1983). Thirty-three children (aged 10, 11, and 12 years at the beginning of the study) participated in the research project that was held for three consecutive nights during yearly evaluations at the Stanford University Sleep Disorders Clinic. They noted that in a previous study Carskadon (1982) had established that 10-year-old children slept for nearly 10 hours, and that Webb and Agnew (1973) had found that young adults slept about 7 hours, 24 minutes, demonstrating this trend of decreasing sleep through adolescence. By maintaining a 10-hour opportunity for sleep in the study, it was expected that a reduced sleep requirement in adolescents would be reflected in lower sleep times as the children grew older. This was not the case, with sleep times remaining constant at about 9 hours, 12 minutes over the years of the study, demonstrating that as the children moved through puberty and adolescence their need for sleep did not decrease.

However, despite the consistent sleep times recorded in this study, as the children reached mid puberty, which was measured by Tanner stages (Tanner, 1962), they became more sleepy during the day. This phenomena of daytime sleepiness was investigated by using the Multiple Sleep Latency Test (MSLT). This test assesses the speed at which a person falls asleep in a 20-minute trial, and was given at 2-hour intervals throughout the day and early evening. The faster a person falls asleep in this test, the higher their level of daytime sleepiness is surmised to be. The findings indicated that daytime sleepiness increased at mid puberty and remained constant, despite the fact that the adolescents were sleeping for the same amount as when younger. Additionally, as the children moved through adolescence they no longer tended to wake spontaneously, but needed to be woken at the end of the designated sleep period.
Taken together, this data could be interpreted as suggesting that adolescents required more sleep than when they were younger. However, on the basis of this study, Carskadon et al. (1983) assert that the optimal sleep length for adolescents is about 9 hours, 12 minutes, which is remarkably similar to the amount of sleep that adolescents say they need, and the amount of holiday sleep that adolescents tend to obtain, particularly in Europe and the US. These laboratory findings have been used extensively in the adolescent sleep patterns literature as a benchmark for adolescent sleep requirements, with several school based studies finding that students accrue a considerable sleep debt during the school week of around 2 hours or more per night. This has prompted researchers to conclude that adolescents are in general, a sleep deprived group (Arakawa et al., 2001; Gau & Soong, 2003; Reid et al., 2004; Wolfson & Carskadon, 1998; Yang et al., 2005).

2.7 Summary of Adolescent Sleep Patterns

The results of the studies discussed so far indicate that as children move through puberty and into later adolescence they undergo a phase delay in sleep patterns, with progressively later bedtimes on both school nights and weekends, and decreasing sleep duration as a consequence of this. A greater discrepancy between weekday and weekend sleep patterns also becomes apparent, with longer delays until bedtime on the weekend, longer oversleeps and longer sleep duration than during the week. During holidays, adolescents tend to adopt a more consistent pattern of sleep that demonstrates a later phase, choosing later bedtimes and wake-up times. Findings have suggested that the variability between week and weekend patterns is not significantly different when school schedules do not impose an early wake time.

Although variations in specific sleep times have been reported from different regions in the world, the overall trends in sleep patterns are similar. European students tend to go to bed earlier and wake later than US students, but the shortest sleep times are in Asia, possibly due to differing school expectations, cultural differences, and differing school starting and finishing times. Furthermore, some researchers have suggested that weekend and holiday sleep patterns may reflect a need to catch up on sleep, and also that they may indicate the natural phase preference of adolescents. In regards to gender differences in sleep patterns it appears that girls tend to get up earlier than boys on school days, perhaps in order to attend to chores or longer grooming routines.
In general, it seems from the literature that adolescents do not obtain anywhere near the amount of sleep during the school week that they say they require, or that has been ascertained as their biological sleep need in laboratory research. However, some studies show that they do tend to sleep for about this length of time on weekends and holidays (Andrade et al., 1993; Hansen et al., 2005; Laberge et al., 2001; Palazzolo et al., 2000). The inference that can be drawn from Carskadon et al’s (1980; 1983) finding, and in light of the research presented so far, is that adolescents are a severely sleep deprived group, particularly during the school term.
Chapter Three: Adolescent Sleep Quality

3.1 Overview

Besides wanting more sleep, it appears that young people experience sleep difficulties, and complain of poor quality sleep. Studies often report on sleep quality or specific sleep difficulties, such as trouble initiating or maintaining sleep. The quality of sleep is largely subjective and usually includes an individual’s evaluation of satisfaction with sleep and sleep duration, as well as including the more objective measures of sleep difficulties, such as problems with initiating or maintaining sleep and early morning waking. For this reason there is some overlap between measures of sleep duration and sleep quality, and between sleep quality and sleep difficulties. This chapter reviews the results of epidemiological studies that have assessed clinical sleep disorders, as well as giving some information on the proportion of adolescents who complain of individual sleep difficulties. In the case of the school-based studies that are presented, most are based on self-reported subjective sleep quality that include assessment of specific sleep difficulties, as well as ratings of overall satisfaction with the quality and duration of sleep. Some hypotheses about possible causal pathways between sleep quality and sleep quantity are also presented, with the suggestion that these two constructs are intricately linked.

3.2 Sleep Quality and Prevalence of Sleep Difficulties

The quality of an individual’s sleep has been described by Buysse, Reynolds, Monk, Berman, and Kupfer (1989) as an important concept due to the apparent frequency of sleep difficulties in the adult population, and also because of its correlation with psychiatric problems. However, these authors also explain that:

Although sleep quality is a readily accepted clinical construct, it represents a complex phenomenon that is difficult to define and measure objectively. “Sleep quality” includes quantitative aspects of sleep, such as sleep duration, sleep latency, or number of arousals, as well as more purely subjective aspects, such as “depth” or “restfulness” of sleep. However, the exact elements that compose sleep quality, and their relative importance, may vary between individuals. Furthermore, because sleep quality is largely subjective, sleep laboratory measures may correlate with perceived sleep quality, but they cannot define it.

(p.194)
Pilcher, Ginter, and Sadowsky (1997) have argued that although sleep quantity and quality overlap to some extent, they are distinct constructs, with sleep quality regarded as a broader variable combining the more objective reports of sleep difficulties as well as the subjective perceptions about the depth, restfulness and overall satisfaction with sleep. Research with university students has also explored this link between sleep quantity and quality. Hawkins and Shaw (1992) measured sleep quality with one item asking for a rating using a visual analogue scale. One further item asked students to record the number of times they woke up during the night. This was done for 7 days, along with a sleep log, at three time points over one semester. Sleep quality was higher on the weekends when students slept for longer, which prompted the authors to hypothesise that longer sleep opportunity may promote higher levels of satisfaction with sleep quality. Similarly, in another study finding that 39% of the university student participants reported poor sleep quality, it was shown that reported sleep duration influenced overall ratings of sleep quality (Medeiros, Mendes, Lima, & Araujo, 2001). Clearly these two constructs of quantity and quality are intertwined, with findings suggesting that when people have more opportunity for sleep they tend to rate their sleep quality as better, while it is also accepted that sleep difficulties, such as problems initiating sleep, may influence the quantity of sleep.

Sleep quality has been measured in a variety of ways. Buysse et al. (1989) developed the Pittsburgh Sleep Quality Index (PSQI) that assesses seven components of sleep quality in adults including sleep latency, sleep duration, subjective rating of sleep quality, sleep efficiency, sleep disturbances, use of sleeping medication and daytime dysfunction. A global sleep quality score is derived from scores on these components. In some adolescent studies sleep quality was assessed by only one or two items. For example, Acebo and Carskadon (2002) measured sleep quality with two items from the School Sleep Habits Survey (Wolfson & Carskadon, 1998), asking about satisfaction with sleep, and how often the participant had a good night’s sleep in the past two weeks. This measure was significantly predicted by school-night sleep time, suggesting that shorter sleep duration was linked with less satisfaction with sleep quality. Andrade et al. (1993) rated sleep quality on the basis of one item about how well the participant thought they slept. This Brazilian study revealed that none of the adolescents rated themselves as being a poor sleeper. The majority (86%) reported that they rated
themselves as very good or good sleepers, with the remainder reporting fair to good sleep. Sleep difficulties were not assessed as part of the sleep quality measure in this study, but were measured separately. Frequencies for these were in accordance with the perceived sleep quality measure – the majority (84%) reported no sleep problems, however 6% of the students reported that they experienced difficulties with waking in the night on a nightly basis, with 17% reporting that this was an occasional complaint for them. It could be inferred from these data that students took specific sleep difficulties into account when rating their quality of sleep.

In the School Sleep Habits Survey (Wolfson & Carskadon, 1998), a 10-item sleep/wake problems behaviours scale is presented that includes items about difficulties falling asleep, sleeping in, erratic sleep patterns, and daytime sleepiness. Results from studies using this scale have shown that adolescents with shorter sleep times during the week also tended to report poorer outcomes on the sleep/wake problems behaviour scale (Gianotti et al., 2002; Wolfson & Carskadon, 1998).

Some school-based research has looked at the prevalence of specific sleep difficulties only. In an Australian study, Bearpark and Michie (1987) collected information from 350 school students aged between 10 to 17 years in Sydney. Results indicated that about 23% of the sample reported difficulty getting off to sleep. Trouble waking in the morning was reported by 18%, followed by 11% who complained of waking in the night. Restless, disturbed sleep and early morning waking was reported by about 5% and 2% respectively. No significant gender differences were found on sleep difficulty measures, however, it appeared that reports of problems getting off to sleep at night, and night waking increased with age with the girls but not the boys.

More recently, another Australian study conducted with 2,361 secondary school students (aged 11 to 18 years), indicated that 30% of the sample self-reported difficulties falling and staying asleep (Waters, Wake, Toumbourou, Wright, & Salmon, 1999). This was rated as the fourth most important health and well-being concern out of 18 concerns listed in the questionnaire, but of the sample, only 2.8% reported that they had sought any assistance with this difficulty. Reported sleep difficulties increased with age, although for males this tended to decrease from 17 to 18 years of age. As females increased in age they were 30% more likely than boys to report difficulty falling or
staying asleep. This study highlighted that there is a discrepancy between what public health bodies perceive as being the main concerns of young people, and the actual personal concerns of youth. In this case, young people expressed more concern with sleep difficulties than concerns such as headaches, bullying, sex, alcohol, and drugs.

Further school-based studies support this view that sleep is an issue of some importance to young people. For example, Gau and Soong (1995) found that about 27% of their sample of junior high students in Taiwan experienced trouble getting off to sleep, however, complaints of night waking and early morning waking were higher (32% and 22% respectively). In France, Mantz et al. (2000) reported that 16% of their sample of 386 adolescents (age 15 to 20 years) reported sleep onset difficulties, with 39% complaining of night waking, and 38% of daytime sleepiness. In another study of French secondary school students, it was reported that 40.8% said that they experienced sleep difficulties, including the need for more sleep (Vignau et al., 1994). In the Netherlands Meijer, Habekothe, and Wittenboer (2000) reported that 15% of their sample of 449 children and early adolescents aged between 9 to 14 years, had sleep problems such as initiating or maintaining sleep.

Two epidemiological studies conducted in New Zealand and in Europe with adolescent samples also support the impression that this group experiences sleep difficulties, although it is problematic to assess overall prevalence rates due to differing reporting methods. In New Zealand, Morrison et al. (1992) conducted a community study using DSM-III (American Psychiatric Association, [APA], 1980) criteria to assess the prevalence rate of sleep disorders. Nine hundred and forty-three adolescents were assessed at 13 years of age and again at 15 years. Findings indicated that about one third of the sample complained of a sleep problem that they had experienced at least four times per week. The most frequent sleep complaints were: needing more sleep (25% of sample) and difficulty falling asleep (10% of sample). Sleep difficulties, particularly reports of multiple problems, were associated with higher levels of depression and anxiety. Fifteen percent of the sample reported trouble falling asleep, as well as night or early morning waking. No significant gender differences were reported.

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3 Several editions of the Diagnostic and Statistical Manual of Mental Disorders are referenced throughout this thesis, reflecting the particular edition utilised in each study.
for these sleep problems, and the authors concluded that multiple sleep problems and insomnia were markers for mental health problems.

In the other study, sleep data were collected in epidemiological surveys in France, Great Britain, Germany, and Italy conducted between 1993 and 1997, with 15 to 18 year-olds (Ohayon et al., 2000). Using DSM-IV (APA, 1994) criteria, they assessed about 4% of the sample as having a DSM-IV diagnosis of insomnia. Of those participants who met the criteria for anxiety or depression, 76% and 67% reported symptoms of insomnia respectively, providing evidence of links between mood and sleep disorders in this age group. Daytime sleepiness was reported by about 20% of all adolescents, and 26% of the participants reported at least one insomnia symptom of either trouble initiating or maintaining sleep.

### 3.3 The Relationship Between Sleep Quality and Sleep Quantity

Some evidence has been presented that as bedtimes become progressively later with increasing age and year level in adolescence, sleep duration decreases and reported sleep quality tends to deteriorate (Arakawa et al, 2001). It is reasonable to expect that with later bedtimes and less sleep, young people tend to become less satisfied with their sleep quality, rating it as poorer, and perceiving their sleep to be more disrupted. On the other hand, some researchers contend that it is sleep difficulties and poor sleep quality that cause sleep deprivation in this age group. For example, Dahl and Lewin (2002) have likened the irregular sleep patterns of adolescents to “jet lag”, with the difference between weekend and weekday bedtimes similar to changes in time zones. They have proposed that this leads to sleep problems such as difficulty falling asleep and that it is this factor that results in sleep deprivation. Evidence supporting this opinion has been offered by Laberge et al. (2001) with the finding that adolescents who tended to lengthen the delay between weekday and weekend bedtimes and increase weekend sleep duration also tended to experience difficulties falling asleep.

Millman (2005) has argued that the main cause of adolescents’ problems with getting off to sleep is due to delayed sleep phase syndrome (DSPS), a more severe version of Dahl and Lewin’s (2002) “jet lagged” irregular sleep patterns. In DSPS the intrinsic biological underpinnings of the sleep/wake cycle, such as rhythms of melatonin onset /offset, and body temperature, are significantly delayed, resulting in unusually late
sleep and wake times. It is inferred that adolescents with this tendency cannot get off to sleep at an earlier time due to these intrinsic processes and that they tend to toss and turn until the early hours of the morning before finally getting off to sleep. However, the only empirical evidence that specifically investigates DSPS in adolescents has been provided by Ohayon et al. (2000), who found that the prevalence rate for this disorder was about 0.04%. Furthermore, adolescents were not found to have a higher prevalence of DSPS than the young adults in the study. Dahl, Ryan, Matty, and Birmaher (1996) have also suggested that emotional arousal caused by negative rumination may interfere with the onset of sleep, impacting on the amount of sleep obtained. However, surprisingly little empirical research has been conducted with adolescents investigating this issue.

There is also evidence that simple bedtime routines and habits are linked with sleep quality. Comparing sleep quality between 572 American and 776 Italian school students (aged 12 to 17 years) it was demonstrated that the Italian students had better sleep hygiene, as defined by their sleep routines and sleeping environment factors, and better sleep quality than their American counterparts (LeBourgeois, Gianotti, Cortesi, Wolfson, & Harsh, 2005). Sleep quality was operationalised as willingness to go to bed, difficulties going to sleep, staying asleep, reinitiating sleep, and waking in the morning. The researchers concluded that good sleep hygiene strongly predicted better sleep quality, and that children and adolescents could benefit from educational programmes that instructed them on the importance of routines that promoted sleep. These routines and habits included behaviours such as restricted use of caffeine, regular bedtime routines, limiting television and loud music before bedtime, limiting bright overhead lighting, and regular sleep patterns. The results of these few studies suggest that there may be many factors associated with sleep quality in adolescents, and many avenues of study in this area still to be explored.

While the consequences of poor sleep quality will be discussed more fully in Chapter Six, the reported correlates of disturbed sleep in adolescents are depressed mood, fatigue, daytime sleepiness, anxiety, suicidal ideation, stimulant abuse, and conduct disorder (Morrison et al., 1992; Patten, Choi, Gillin, & Pierce, 2000; Roberts, Roberts, & Chen, 2001; Vignau et al., 1994). Subjective sleep quality was also found to be correlated with achievement motivation in the Netherlands study, with the conclusion
drawn that sleep difficulties affected functioning and performance (Meijer et al., 2000). In addition, poor sleep has been linked with irregular sleep/wake patterns, tendency to skip breakfast, higher incidence of illness, and lack of exercise (Tanaka et al., 2002).

### 3.4 Summary of Adolescent Sleep Quality

Although the literature is sparse, it seems that adolescents often identify themselves as experiencing poor quality sleep and report that it is of concern to them. While it is difficult to compare results, given the differences in data collection, definitions and methodology, it does seem clear that a significant proportion of school students experience poor quality sleep, complaining of dissatisfaction with sleep, having problems getting off to sleep, and staying asleep at night. Long sleep latencies prevent students from obtaining as much sleep as they require during the school term. It has also been speculated that as adolescents are developmentally vulnerable to a phase delay, this may tend to make sleep onset difficult at a time early enough in the evening to obtain sufficient sleep for their needs. Apart from this view, suggesting that poor sleep quality in the form of sleep difficulties leads to insufficient sleep, there is also evidence that the link between sleep quality and sleep duration may be bi-directional – with longer sleep duration or sleep opportunity leading to higher subjective sleep quality. It seems apparent that sleep quantity and quality are intricately linked in the case of adolescents, and that further research might provide additional insight into the nature of the relationship.
Chapter Four: Biological Factors Affecting Adolescent Sleep Patterns

4.1 Overview

In this chapter the biological factors that impact on adolescent sleep patterns are discussed. Endogenous factors, such as circadian rhythms, melatonin secretion and individual circadian preference are theorised to affect the changes in sleep patterns that have been observed in adolescents. Due to the limited research that has been conducted with adolescent populations, a review of current knowledge based on research with adult samples about circadian rhythms, the role of melatonin and individual circadian preference is presented. After this background, the more recent studies undertaken with adolescents are reviewed.

4.2 Circadian Timing and Sleep

The sleep/wake cycle is part of the biological rhythm of daily life. Endogenous physiological rhythms that occur during a 24 hour time period are called circadian rhythms, from the Latin ‘circa diem’ (about one day). Blood pressure, heart rate, core body temperature, endocrine, immune and urinary systems have all been found to have daily rhythms (Moore-Ede, Sulzman, & Fuller, 1982). These rhythms are termed endogenous because they are internally generated, and are not just a response to the environment. For instance, an endogenous circadian rhythm will persist even when environmental cues are removed, and will remain at about 24 hours of periodicity irrespective of a different time frame being imposed on the organism (Hobson, 1995; Lavie, 2001). In fascinating research conducted with astronaut Jerry Linenger on board the Mir space shuttle as it orbited earth, it was reported that his circadian pacemaker functioned well in regard to body temperature, alertness and sleep for over 90 days, despite weightlessness, absence of natural time cues from earth, and the considerable stress of the mission. Only after 3 months was there a noticeable weakening of Linenger’s circadian rhythms (Monk, Kennedy, Rose, & Linenger, 2001).

In several early experimental studies conducted in Germany, the rest/activity, sleep/wake, and core temperature circadian rhythms in humans were investigated. These experiments were described as “free running,” as participants were isolated from environmental cues such as clock time and social activity, although they could control overhead lighting themselves. These external environmental cues, called ‘zeitgebers’
The intrinsic circadian period of sleep/wake and core temperature were first thought to be closer to 25 hours as a result of early experiments (Wever, 1979). However, subsequent research in this area has become more sophisticated, with more stringent protocols utilised, particularly around the use of room lighting in experiments, and the circadian pacemaker that controls the sleep/wake cycle and other biological processes has been found to be fairly stable at around 24 hours (Czeisler et al., 1999). In a forced desynchrony protocol (where a 28 hour schedule was imposed) 10 adolescents (mean age 13.7 years) were found to have intrinsic circadian rhythms of just over 24 hours (Carskadon, Labyak, Acebo, & Seifer, 1999).

The human circadian pacemaker controlling physiologic processes, including core temperature, melatonin secretion, sleep/wake propensity, and sleep structure, is located within a group of cells called the suprachiasmatic nuclei (SCN) in the anterior hypothalamus of the brain. The SCN receives light information from the retina and the retino-hypothalamic tract, which is different from the pathways involved in processing visual images. Thus, blind people who still have light perception, but little or no vision, are able to maintain a circadian rhythm in synchronicity with light/dark cycles (Dijk & Lockley, 2002; Lavie, 2001). Dijk and Lockley (2002) maintain that many processes, both endogenous and external, such as melatonin and temperature variations, light and dark signals, and sleep/wake cycles are intricately intertwined, and that sleep difficulties may be the result of variations and disruptions in these closely related systems.

4.3 The Role of Melatonin and Core Body Temperature in Circadian Phase and the Timing of Sleep

Daily rhythms in melatonin and core body temperature are two important endogenous processes that are involved in the timing of sleep. Secretion of the hormone melatonin is regulated by the circadian pacemaker in the SCN. It is secreted by the pineal gland, which is attached to the posterior of the third ventricle in the brain. Information about light exposure is first relayed to the SCN via the retina and retino-
hypothalmic tract, which in turn signals the pineal gland. The synthesis of melatonin, which is a derivative of the amino acid tryptophan, is stimulated by darkness and inhibited by light. Melatonin secretion increases at the end of the day as darkness falls, and continues to rise until the early hours of the morning, falling to low levels during daylight hours (Cavallo, 1993). Conversely, core body temperature falls at night when a person is less active, and together this process of falling body temperature and rising melatonin levels induces the feeling of sleepiness (Saarela & Reiter, 1994). Core body temperature continues to fall until its minimum near the end of the sleep period. For the purposes of research, melatonin levels can be measured in saliva, blood, and urine, and along with temperature fluctuations have been found to be reliable measures of circadian phase (Arendt, 2003; Burgess et al., 2003; Martin & Eastman, 2002).

Research suggests that light, even moderate levels of room lighting, can delay or advance the phase of a person’s body temperature and melatonin secretion rhythm through its effect on the circadian pacemaker controlling these functions (Boivin, Duffy, Kronauer, & Czeisler, 1994; Shanahan et al., 1997; Smith & Trinder, 2005; Trinder, Armstrong, O’Brien, Luke, & Martin, 1996; Zeitzer, Dijk, Kronauer, Brown, & Czeisler, 2000). Bright light exposure at night has been found to suppress melatonin and enhance alertness, as measured by eye movements and EEG activity, as well as by self-reports of sleepiness. Even typical room lighting was found to impact on these variables (Cajochen, Zeitzer, Czeisler, & Dijk, 2000). Trinder et al. (1996) found that the rise of melatonin was delayed by about an hour at low levels of light (250 lux), while at high light intensity (500 to 2,500 lux) it was suppressed, and did not rise again until the end of the light period. Researchers have concluded that the human circadian pacemaker seems to be more sensitive to light than was at first thought. They suggest that exposure to light at night may have implications for some sleep disorders, particularly sleep onset difficulties, and phase delays (Boivin et al., 1994; Trinder et al., 1996).

Beyond its capacity to shift the circadian phase of the melatonin rhythm via the SCN, light also directly affects melatonin secretion. For researchers interested in the circadian rhythm itself, this “masking” effect must be carefully controlled to permit identification of circadian parameters. Dim light salivary melatonin onset/offset (DLMO) is currently the accepted method for research using increased nocturnal melatonin onset, or melatonin offset, as markers of circadian phase. This protocol involves constant dim lighting (about 20 lux) in the laboratory for the duration of the
saliva testing period, whereby samples are collected at regular intervals (Carskadon & Acebo, 1997; Martin & Eastman, 2002).

Studies measuring circadian phase with the DLMO protocol have found that endogenous melatonin onset is significantly related to sleep onset and offset and occurs about 2 hours before sleep onset (i.e. about 14 hours after wake time) in young adult subjects (Burgess et al., 2003; Martin & Eastman, 2002), and just over 2 hours before sleep in adolescents (age range 14 to 16 years) (Tzischinsky et al., 1995). Burgess et al. (2003) argue that the mid-point of self-selected regular sleep routines are also reliable measures of DLMO phase, on the basis of their study with 16 young adults.

While the effects of light on the timing of melatonin have been well explored, some evidence has also been presented that suggests that non-photic factors may influence melatonin timing. For example, Higuchi, Motohashi, Liu, Ahara, and Kaneko (2003) conducted an experiment where seven male subjects performed tasks on video display terminals with either a bright or dark intensity of light, and a boring or stimulating task. Findings suggested that performing an exciting task, in this case a shooting game, with a bright display intensity suppressed the onset of melatonin and core body temperature changes at night. This finding suggested that cognitive stimulation in conjunction with light cues could be implicated in the entrainment of circadian rhythms.

Similarly, Goel (2005) provided some evidence that auditory stimulation during the early evening significantly delayed the timing of melatonin onset. This small study with ten subjects, showed that subjects were more alert after the auditory stimulus than the controls. Additionally, over-the-counter medications such as aspirin and ibuprofen have been reported to suppress melatonin if administered at night, and coffee consumption has been shown to result in decreased melatonin levels on the following night (Murphy, Myers, & Badia, 1996; Shilo et al., 2002). These findings, although conducted with adults, are relevant to the types of activities that are common for adolescents, such as playing computer games and listening to music before bed. The implications of these studies are that leisure activities such as these may delay the timing of nocturnal melatonin onset, which in turn could delay the timing of sleep.

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4.4 Morningness–Eveningness as a Measure of Individual Circadian Preference

Morningness–Eveningness is the spectrum of individual preferences for the timing of daily activities. It is also often referred to as circadian preference, circadian type, or chronotype. Using self-assessment questionnaires, such as the Morningness–Eveningness Questionnaire (MEQ, Horne & Ostberg, 1976), individuals are asked to report on their peak times for activities such as exercising and concentrating on mental tasks, as well as preferred bedtime and wake times. Research using adult participants has found that the majority of individuals fall into the intermediate, or neutral category, and report their peak performance at around the middle of the day, with the minority selecting either morning or evening as their preferred time for performance activities (Cofer et al., 1999; Horne & Ostberg 1976; Gilbertini, Graham, & Cook, 1999; Smith, Reilly, & Midkiff, 1989).

Morningness–eveningness is particularly expressed in sleep-wake cycles, with those who are classed as morning types tending to go to bed earlier and wake earlier than evening types. Morning types find getting up in the morning easy, they feel alert and ready for activity in the morning, more so than in the evening. For evening types, the tendency is to stay up late, sleep later and take some time to get going in the morning, reporting that they feel more alert in the evening than the morning (Bailey & Heitkemper, 2001; Duffy, Rimmer, & Czeisler, 2001; Horne & Ostberg, 1976; Taillard, Philip, & Bioulac, 1999; Vink, Groot, Kerkhof, & Boomsma, 2001).

Self-reported morningness–eveningness is also closely related to physiological circadian processes. Research under controlled conditions shows that individual circadian rhythms of core temperature, cortisol and melatonin secretion is earlier for morning types than for evening types, whose timing for these processes tends to be delayed (Baehr, Revelle, & Eastman, 2000; Bailey & Heitkamprer, 2001; Griefahn, 2002; Lewy & Sack, 1989; Lewy, Cutler, & Sack, 1999), and scores on the MEQ have been reported to be well correlated with the phase of the circadian temperature rhythm ($r = .52$). Consequently, some research has favoured the use of self-reported morningness–eveningness over other costly and time-consuming methods of estimating circadian phase such as measuring melatonin levels or core body temperature, particularly in larger samples (e.g., Murray, Allen, & Trinder, 2003). Researchers such as Trinder et al. (1996) have speculated that perhaps evening typed people are more
susceptible to light intensities at night than are morning types, and that this may inhibit melatonin onset at night, thus delaying their sleep onset times and delaying their phase. The timing of melatonin onset and offset has also been found to be related to a preference for morning or evening activities in studies that have used adolescents, young adults and older adults (Duffy, Dijk, Hall, & Czeisler, 1999; Laberge et al., 2000).

A number of other behavioural and psychological factors have been found to differ according to chronotype in research with adults. For example, evening types tend to report lower sleep quality, and more irregular sleep schedules with much greater variability between weekday and weekend sleep patterns than morning types (Medeiros, 2001; Taillard et al., 1999). Furthermore, one study found that about 40% of evening types extended sleep for over 10 hours on the weekend. However, they were more likely than morning types to get less sleep than they said they required during the week due to their greater reported need for sleep (Taillard et al., 1999).

Research into shiftwork suggests that evening types are more suited and adaptable to night shift work than morning types, who tend to be less flexible about bed and wake times (Ostberg, 1973). Individuals with a morning preference have also been found to lead a more regular lifestyle, in terms of the more rhythmic patterns of their daily activities. It has been suggested that this puts them at an advantage for school and the workplace, while those with an evening preference may find it difficult to organise themselves for early starts and performance based activities (Monk et al., 2004).

Other findings indicate that morning types have more positive mood and perform better in the morning than they do in the evening, with the reverse occurring for evening types (Johansson et al, 2003; Kerkhof, 1998; Kerkhof, Korving, Willemse-vd Geest, & Rietveld, 1980; Watts, Cox, & Robson, 1998). A study with university students found that evening types tended to prefer later class times than morning types, and to report that they experienced lower alertness and learning ability in the morning and higher performance in the evening (Cofer et al., 1999). University students who stayed up regularly watching late night television were also found to be more evening typed than those who did not (Harada, Kadowaki, Shinomiya, & Takeuchi, 2004).
In addition, self-report surveys show some links with personality variables, with evening types found to be more impulsive, but tending to score higher on intelligence measures, while morning types tended to indicate higher levels of persistence than evening types (Caci, Roberts, & Boyer, 2004; Roberts & Kyllonen, 1999). Eveningness has also been linked with the personality measure of neuroticism (Mura & Levy, 1986), although Adan (1994) found no link between chronotype and neuroticism, extroversion or psychoticism. Horne and Ostberg (1977) found no significant association between chronotype and extraversion-introversion. Even differences in substance use have been noted by Adan (1994) who found that evening types consumed more alcohol, nicotine, coffee and cola drinks than morning types, who tended to consume more tea containing caffeine. It has been speculated that caffeine consumption by evening types may be an attempt to counteract feelings of sleepiness during the day.

Morningness-eveningness as a measure is generally regarded as a stable, trait-like construct (Monk et al., 2004), with previous work finding no significant differences in average group scores on the MEQ over time (Murray et al., 2003). However, older adults tend to score higher in morningness than younger adults (Duffy et al., 1999; Gilbertini et al., 1998; Monk et al., 2004; Taillard et al., 1999), and it has been suggested that this may be due to increased work and family responsibilities that individuals tend to take on as they become older (Monk et al., 2004). Other researchers propose that endocrine factors influence this age related trend toward morningness (Park, Matsumoto, Seo, Kang, & Nagashima, 2002).

Gender differences in preference for morningness-eveningness are less clear, with some authors such as Kerkhof (1985) arguing that findings are inconsistent, or show no differences (Cofer et al., 1999; Takeuchi et al., 2002), while other authors assert that males are more oriented towards eveningness than females (Adan & Natale, 2002; Roenneberg et al., 2004; Vink et al., 2001). Gilbertini et al. (1998) found by inspecting melatonin acrophases (peaks) that women were more phase advanced than men, although both males and females in their study were distributed about equally through the chronotypes. There is also some evidence for a genetic link in preference for morningness or eveningness (Vink et al., 2001). In reviewing the literature, there appears to be good evidence that self-reported morningness-eveningness can be considered an indication of an individual’s intrinsic circadian phase. These individual
differences in chronobiology also seem to influence the timing of daily activities such as preferred sleep/wake cycles and periods of maximum alertness and performance, with morning types preferring earlier bed and wake times, activities and performance during the day, and evening types having a preference for later bed and wake times and performance based activities much later in the day, or in the evenings.

4.5 Adolescent Studies: Cohort Changes in Circadian Timing

Expanding on the findings that adolescents do not have a decreased need for sleep, but tend to delay bedtime even though they must get up early for school, research has been conducted to explore the proposition that the biological processes of pubertal development may mediate a phase delay in adolescence. Studies have utilised the protocols developed with adults such as dim light melatonin onset/offset (DLMO) collection, sleep habits and morningness-eveningness questionnaires, as well as including measures of pubertal development, in order to further explore the delayed timing of sleep in this age group. Several important findings have been documented that provide good evidence that there may be a biological underpinning to the changes in sleep patterns during adolescence.

Firstly, the use of morningness-eveningness scales has provided useful information in research with adolescents. Generally, no significant gender differences in scores have been reported (Caci, Robert, Dossios, & Boyer, 2005; Carskadon, Veira, & Acebo, 1993; Gau & Soong, 2003; Gianotti et al., 2002; Takeuchi et al., 2002), and importantly, significant correlations have been found between sleep patterns and circadian preference scores, indicating that adolescents with a morning orientation tend to favour an earlier bed and wake time than those with an evening preference (Andrade, Benedito-Silva, & Menna-Barreto, 1992; Carskadon & Acebo, 1992; Carskadon et al., 1993; Gianotti et al., 2002).

Andrade et al. (1992) reported that in addition to sleep patterns, morningness-eveningness was also significantly correlated with temperature acrophase, (a marker of circadian phase) in a sample of 62 adolescents (mean age 13 years, 6 months). This longitudinal study administered the Morningness-Eveningness Questionnaire (MEQ, Horne & Ostberg, 1976) on three occasions at six monthly intervals, with significant correlations between the measures at each time point, giving further support to
morningness-eveningness reflecting circadian phase preference. Temperature acrophase, sleep onset and wake up occurred earlier for morning type children than those classified as evening types.

Moreover, evidence has been found that links pubertal stage with morningness-eveningness. For example, Carskadon et al. (1993) surveyed 183 sixth grade boys and 275 sixth grade girls (11-12 years), estimating their physical development and also their circadian phase preference (morningness-eveningness) by means of a self-report questionnaire. Their measure for morningness-eveningness was adapted from a composite scale for adults developed by Smith et al. (1989), while pubertal status was ascertained by Tanner stages (Tanner, 1962). Pubertal stage and circadian preference were significantly linked for girls, and although there was a tendency towards this in boys, it was not significant. The less mature girls showed a morning tendency, while more mature girls preferred the evening hours. Maturation stage was found to be more influential than psychosocial factors on the phase preference of the children. This study provided some evidence that biological processes may be implicated in the later timing of adolescent sleep.

Similar conclusions have been drawn by Laberge et al. (2001) who conducted a three-year longitudinal study with children aged 10 to 13 years. Children with a higher pubertal score tended to have longer sleep duration times and later wake times on the weekend. The gender differences that were found in this study (i.e. girls tended to have a later weekend phase delay than boys) could also be accounted for by the girls’ higher pubertal scores. They concluded that puberty affected the timing, patterns, and need for sleep, and that this was most evident on weekends when the participants were not constrained by school schedules. Further observations were made by Shinkoda, Matsumoto, Park, & Nagashima (2000), who demonstrated that evening preference increased with age, and sleep length of weekdays decreased with age in their sample of 512 school students (aged 6 to 18 years). They found that children changed to more of an evening orientation at around Grade 7, which is also about the start of puberty for most children. Recent work by Gau and Soong (2003) is consistent with these findings.

In another longitudinal study by Andrade et al. (1993) it was reported that social factors, such as home conditions and daytime schedules, did not alter over the course of
their longitudinal study, but a change in the sleep patterns of their sample of 12 to 16 year olds was detected over time. Wake up times became later and weekend sleep time was extended, with the researchers concluding that pubertal development, as measured by Tanner stages, had influenced the observed changes in sleep patterns.

Perhaps the strongest evidence that a phase delay in adolescence is mediated by puberty has been provided by Carskadon and Acebo (1997). This research sought to link developmental stage during adolescence with a change to a later circadian phase, as measured by DLMO. A group of 10 boys (11 to 14 years) and 9 girls (12 to 14 years) took part in the research. The children wore actigraphs and kept sleep logs at home, and polysomnography was also used in the laboratory to measure sleep times.

Carskadon and Acebo (1997) demonstrated an association between the melatonin secretion offset and pubertal phase, as measured by Tanner scales, and age. This indicated that as children became older and progressed through puberty they tended towards a later phase of melatonin offset, suggesting a biologically mediated later phase. Subsequently, Carskadon, Acebo, and Jenni (2004) reported that in a group of 27 adolescents melatonin onset was found to be well correlated with pubertal stage in controlled conditions. It has been concluded that in addition to the psychosocial factors that may influence adolescent sleep patterns, such as decreased parental involvement in setting bedtimes and increased social opportunities, the phase delays observed in the teenage years are also influenced by the biological maturational processes of puberty (Carskadon & Acebo, 1997; Carskadon et al., 2004).

4.6 Light Exposure and Circadian Timing in Adolescents

Light and dark cycles are the major entrainers of the human circadian system, and some studies have investigated how behaviourally influenced light exposure might amplify circadian phase differences in adolescence. For example, in Carskadon and Acebo’s (1997) study on the later circadian phase in adolescence, results implied that the phase delay could be rectified with an enforced schedule that controls light exposure. Some of the participants who had a later melatonin phase in the self-selected condition, were found to have changed to an earlier phase, as measured by DLMO, during the entrained condition. This was reversed for some of the participants who had an earlier phase in the self-selected condition. This indicates that although adolescents
may have a biological tendency toward a late phase, it can be modified (Carskadon, 1999; Carskadon & Acebo, 1997). Carskadon (1999) has speculated that adolescents may be less sensitive to light in the morning and more sensitive to light in the evening, thus tending to entrain their circadian rhythm to a later phase, and resulting in the delayed onset of sleep that is commonly observed.

Extending this perspective, Harada (2004) presented evidence that exposure to bright lights can alter the timing of melatonin onset and circadian phase in adolescents. The effects on salivary melatonin secretion when exposed to bright lights in the first half of the evening before bedtime were investigated. Four females and six males aged between 14 to 15 years were exposed to bright light (2000 lux) or dim light (60 lux) between 6:30 p.m. to 10:30 p.m. on one evening, finding that for those participants in the bright light condition, melatonin secretion was inhibited as compared to the control group in the dim light condition. It was also observed that those in the dim light condition had a more rapid rise in salivary concentration of melatonin in this condition than they did on the previous evening when base levels were recorded. Harada concluded that bright lights, as well as more moderate room lights, could inhibit melatonin secretion onset in adolescents, thus interfering with the timing of sleepiness and delaying sleep. The suggestion was made that this age group should use very low levels of light in the evening to facilitate the feeling of sleepiness and readiness for bed.

Harada, Morisane, & Takemeuchi (2002) also demonstrated a correlation between the exposure to daytime sunlight conditions and circadian rhythms in their study of 415 girls and 411 boys in Japan, aged 12 to 15 years old. Interestingly they found that students who tended to go outside in their recess and lunch breaks tended to have a morning orientation, whereas those who chose not to go outside into the sunlight tended to be evening types. They have suggested that this propensity for going outdoors may help to entrain the circadian pacemaker to an advanced phase (morningness).

Taken together, the studies presented provide strong evidence for a biologically mediated later sleep/wake phase in adolescents. In addition, studies investigating the effects of lighting suggest an intricate interaction between environmental, behavioural, and biological factors in regards to the entrainment of the adolescent circadian phase. As Carskadon (1999) has pointed out, not enough is known about the effects of lighting
from the use of television and computer screens at night and how these may further intensify the effects of the adolescent phase delay.

4.7 Individual Differences in Morningness-Eveningness for Adolescents

As presented in the previous section, morningness-eveningness research with adolescents has mainly focussed on the cohort shift to later timing or phase preference of the sleep/wake cycle that has been a central finding in adolescent sleep patterns (Andrade et al., 1992; Carskadon & Acebo, 1992; Carskadon et al., 1993; Laberge et al., 2001; Shinkoda et al., 2000). However, Cofer et al. (1999) suggest that although there is a group shift towards a more evening orientation, individual differences in morningness-eveningness are still preserved, even through adolescence. These authors conducted a study using college students aged 16 to 32 years, by measuring their current chronotype on the Morningness Eveningness Questionnaire (MEQ, Horne & Ostberg, 1976), and then asking them to retrospectively fill in surveys about their preferences and habits during their school days.

Cofer et al. (1999) found no evidence of large changes such as individuals changing from morning types to evening types, nor did it appear that morning types changed to neutral or neutral to evening types, but rather, during adolescence evening types tended to exhibit even more “evening” type preferences.4 Their study highlighted that morning types tended to maintain quite rigid patterns, even through adolescence when they presumably encountered the same pressures to socialise until later and fit more into their schedules. The findings of this study suggested that by university level, the distinctly evening types had chosen later times than morning types for classes when given the opportunity, and no differences were found in university grades between circadian types.

This study was also interesting because it investigated and discussed the possible developmental outcomes of children and adolescents who tended to be distinctly or extremely evening typed during their school days. It was found that evening types were more likely to have experienced greater family conflict around getting out of bed, getting ready for school, and daily routines. The authors speculated that performing at

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4 Morningness-eveningness can be operationalised as either a categorical or dimensional measure.
school may also have been problematic for these young people who tended not to be alert in the mornings. This in turn may lower an evening type’s achievement at school, perhaps with the consequence of these children and adolescents developing a negative perception of school. Cofer et al. (1999) argued that parental support and understanding was most important for evening types in order to provide adequate or additional structure to enable them to adapt to school schedules. Further studies that track the individual preferences for morningness-eveningness and the correlates and developmental outcomes related to preference over time would be beneficial, but to date there is very little to be found in the literature.

One study that has focused on circadian preference in adolescents aged 14 to 18 years was conducted by Gianotti et al. (2002) in Italy, using the School Sleep Habits Survey (Wolfson & Carskadon, 1998). In line with the findings from other studies that report that adolescents become more evening type, Gianotti et al. found that scores on morningness-eveningness were weakly correlated with age, indicating support for this trend. However, this epidemiological survey of 6631 adolescents during school term clearly demonstrated that not all adolescents become evening types, with 1005 (15%) distinctly morning types and 742 (11%) distinctly evening types identified by the morningness-eveningness scale in the School Sleep Habits Survey. In this study, no gender differences were found in morningness/eveningness scores.

Several important differences were noted between the morning and evening chronotypes during school time. Participants who were classified as evening types reported less satisfaction with subjective sleep quality, and experienced more sleep/wake problems as measured on the Sleep/Wake Problems Behaviour Scale. Although evening types were much more likely to rate their sleep quality as poor, no significant differences were found between evening types and morning types on any of the sleep difficulty items, except for evening types reporting that they had slightly more difficulty with getting off to sleep than morning types. Evening types reported that they needed about one hour more sleep than the morning types, however they tended to go to bed later, obtaining about 30 minutes less sleep than morning types on week nights. They also tended to use more sleeping medications than morning types. Although the sample as a whole tended to have later bed times, wake times, and longer sleep times on the weekends, evening types went to bed the latest, woke up the latest, and slept for
about one hour longer than morning types, demonstrating a more irregular sleep pattern. Similar findings were also reported by Andrade et al., (1992), Carskadon and Acebo (1992), and Gau and Soong (2003).

Furthermore, in the sample of Gianotti et al. (2002), the evening types reported that they felt particularly sleepy in morning class, were unable to concentrate well, and had a higher incidence of accidents as compared to morning types, as well as more depressed and anxious mood, with girls tending to report a higher level of these emotional concerns. Evening types tended to use more alcohol, tobacco, caffeine than morning types, with the older evening type boys being more prone to report these habits as well as the tendency to achieve lower academic grades. Morning types, on the other hand, demonstrated more regular lifestyles, with more regular sleep/wake patterns, better sleep quality, better school attendance, higher alertness and higher achievement at school. Gianotti et al. concluded that evening types found adjusting to the requirements of the school schedule more difficult than morning types.

Similarly, Mercer et al. (1998) had previously noted that those participants in their study of 1457 Grade 9 students (mean age 14.5 years) who reported that they needed more sleep tended towards eveningness. These students said that they needed about 9 hours, 12 minutes of sleep, which was about an hour more than other students reported that they needed. This group tended to have greater levels of daytime sleepiness, more sleep problems, generally taking longer than 30 minutes to fall asleep, and reported only fair or poor subjective sleep quality, along with more depressive mood symptoms, and the feeling of being stressed about school. Recent work in France also suggests that eveningness is a risk factor for depression in adolescence, finding a link between two measures of depression and scores on the MEQ (Caci et al., 2005).

In terms of sleep quality, Gianotti et al. (2002) argued that in order to gain sufficient sleep, evening types would probably need to go to bed at a time of the evening when they are feeling at their most alert. Even if they went to bed early these researchers suggest that they would not be able to get off to sleep until their endogenous circadian phase allowed, leading to sleep onset difficulties and reports of lower sleep quality. However, the evidence from this study showed only a slight increase in reported sleep onset problems for evening types as compared to morning types, not fully
accounting for the lower ratings of sleep quality. Another explanation for the evening types’ much poorer ratings of sleep quality might be their dissatisfaction with sleep in general. They say they need more sleep, but get less sleep than morning types, and furthermore have to sleep and wake up at times not conducive to their circadian phase due to school start times. It could be speculated that these factors would also be instrumental in evening types’ much poorer ratings of sleep quality than those of the morning types.

Evidence from Medeiros et al.’s (2001) study with morning type and evening type medical students who had 7 a.m. and 8 a.m. classes also supports this argument. Although they proposed that circadian preference directly influenced sleep quality due to irregular sleep patterns, their data showed that quality ratings were influenced by the satisfaction with the sleep duration item on the sleep quality scale. Thus, it appears evident also in this study that evening types were less satisfied with their sleep quality due to this reason, tending to rate their subjective sleep quality as poor.

The findings from these studies suggest that an individual preference for eveningness tends to create an additional risk factor for a number of sleep related factors during school term, over and above the cohort effect of a later sleep/wake phase. However, studies have not specifically tested this. Moreover, evening preference seems to be an added vulnerability to a number of other negative outcomes and behaviours for adolescents, suggesting that adapting to the regularity and timing of the school schedule are a significant challenge for them. These issues will be discussed more fully in Chapter 6, covering research that is consistent with findings with adults, particularly in regard to the irregularity of evening type sleep patterns, poorer sleep quality, need for more sleep, difficulties with daytime concentration, lower daytime mood, lower academic grades, and greater substance use, possibly used to attempt to counteract feelings of sleepiness during the day, or to promote sleepiness at night (Duffy et al., 2001; Medeiros et al., 2001; Monk et al., 2004; Taillard et al., 1999; Vink et al., 2001).

While causal relationships have not been established, some researchers have proposed that evening types experience poorer quality of sleep due to irregular sleep patterns and sleep onset difficulties, resulting in insufficient sleep for the individual in the context of fixed school/class start times. They suggest that this pathway in turn
influences functioning during the day, mood, use of substances, and subsequently academic performance (Gianotti et al., 2002; Medeiros et al., 2001). However, as the evidence for evening types being more prone to particular sleep difficulties was not particularly convincing in these two studies, it could also be proposed that those with an evening preference were more dissatisfied with the amount of sleep obtained due to early class scheduling, and having to sleep and wake at times that might be very different to self-selected times in comparison to morning types, resulting in ratings of poor subjective sleep quality. Presently it is unknown if this dissatisfaction with sleep quality, irregularity of sleep patterns, and increased sleep problems by evening types occurs when sleep/wake schedules are largely self-selected, such as during holiday time. These links appear to be a worthwhile focus of research and further validation in regards to adolescent sleep and its impact on day-to-day functioning.

### 4.8 Summary of Circadian Timing and Morningness-Eveningness in Adolescence

The literature reviewed to date indicates that as children move through adolescence they tend to delay their sleep phase, with more of a tendency towards eveningness, and a later intrinsic circadian phase as measured by melatonin secretion. There is evidence that these processes are influenced by biological maturational processes at puberty and that this may make it difficult for adolescents to manage their sleep/wake cycle to accommodate sufficient sleep before getting up early for school. Carskadon (1999) describes this delayed phase evident in adolescents as the “forbidden zone” of sleep, when they find that they cannot go to sleep, tending to lie awake for a long time before their body is ready for sleep. These studies provide a framework to understand the observations by parents that teenagers tend to “come alive” in the evenings despite their heavily scheduled day, and feel unable to sleep until late evening, or for some, the early hours of the morning. They also feel unable to get up in the morning as they still have a biological need for sleep that is similar to their childhood requirements.

There is also evidence that besides the cohort effect of a later phase tendency, there remain individual differences in circadian preference that additionally impact on the daily lives of adolescents. Studies have shown that adolescents can still be placed along the continuum of morningness/eveningness and identified as morning, neutral, or evening types. As Cofer et al. (1999) point out, those with a morning, or indeed a
neutral circadian preference, are at an advantage over evening types, as their period of greatest alertness and performance falls within the school schedule. Evening types, on the other hand, are required to be at school in the latter part of their natural sleep phase. Not surprisingly, they complain of poor alertness and performance at this time. Gianotti et al.’s (2002) research also points to an individual preference for eveningness having implications for other aspects of adolescent life, such as substance use, mood, and school achievement.

There is also some evidence from the laboratory that delayed phases can be advanced if a sleep/wake schedule is adhered to, and that behavioural aspects, such as exposing oneself to bright lights at night, or avoiding daytime light, may entrain circadian rhythms to a later phase. These findings point towards the behavioural aspects of adolescence that may reinforce a delayed circadian phase.
Chapter Five: External Factors that Affect Adolescent Sleep

5.1 Overview

Non-biological factors that impact on the amount of time that adolescents have available for sleep are discussed in this chapter. Research has indicated that biological variables appear to have greater impact on adolescent sleep patterns than social factors. However, issues such as parental control, part-time work, socialising, technological entertainment, mobile phones, as well as environmental factors such as school schedules, have been forwarded as important influences to be considered. Literature based on empirical studies is remarkably sparse in regard to these issues, except in the case of school start times. Although the current project does not directly investigate many of these topics, this brief section will outline some of these issues that have been raised by researchers and commentators in the adolescent field, and report on the results of research where available, in order to provide contextual background for the current work.

5.2 The Importance of Cultural Differences in Sleep Patterns

When considering the sleep patterns of children Owens (2004) has argued that biological and cultural practices are intertwined and therefore the beliefs and expectations of parents about the importance of sleep are a salient influence on children’s habits. The environment that is provided by families for a child to sleep in is also important and may differ culturally. She points out that in some cultures co-sleeping and room sharing is regarded as the norm, particularly for younger children, whereas in some societies this is not common practice. For instance, in one cross cultural study it was found that for American adolescents, better sleep quality was reported when the adolescent did not share a room, but this was not the case for Italian adolescents (LeBourgeois et al., 2005).

The routines about bedtime and sleep that are instigated in childhood may also influence children’s sleep habits as they grow older, and might include such traditions as the midday “siesta”, or after school nap that influence bedtimes and nocturnal sleep times. The expectations of peers in terms of social activities, and the expectations by society around such issues as academic performance and the competitive cultures that have developed in countries such as Korea and Japan, have all impacted on adolescent
sleep and may be quite particular to one culture. For example, Yang et al. (2005) reported that 71% of the students in their Korean survey attended night school, while this is not common in other countries. Parenting practices differ too, with some societies being regarded as more permissive than others. This may impact on the freedom of adolescents to socialize, watch television, access mobile phones and the internet, and to set their own bedtimes. Accordingly, the research conducted in one country on any of these issues may not be generalisable to adolescents elsewhere, however, some idea may be gained of the types of factors that influence adolescent sleep.

5.3 Parental Control

One of the hallmarks of the progression through adolescence is the increased freedom that young people experience in regards to parental control over their lives. Adolescents are usually encouraged to make more and more decisions for themselves as they grow older and it appears that one of these areas that are left to their own discretion is the issue of bedtime and getting adequate sleep. In a study that looked at health data from several European countries, Tynjälä, Kannas, and Välimaa (1993) found that the countries where parents had more control over adolescent behaviour also reported longer sleep times.

Parental control over bedtime decreases with school year level (Yang et al., 2005), with only about 0.6% of the senior high students reporting that parents controlled their bedtime. In stark contrast, parental involvement in waking students increased by age, with 59% of the senior students being woken by their parents for school. Likewise in Italy, parental control over bedtimes also decreased from 3% at 15 years to 0.9% at 18 years. On weekends parents had increased monitoring over bedtime, but only for girls, who tended to get more sleep than boys on the weekends (Gianotti et al., 2005). Carskadon (2002) reports that in a sample of 13 to 19 year old high school students, only 5.1% of adolescents reported that their parents had input into bedtime. Rather, 44% of students went to bed when they felt sleepy, while about 13% cited the completion of homework as their cue for bed. A further 9% went to bed at the finish of their television viewing and around 11% went to bed after social activities had ended. These findings suggest that parents trade setting and monitoring bedtimes for the onerous task of getting their teenager out of bed in the morning.
5.4 Students’ Perceptions of Why They Obtain Insufficient Sleep

Yang et al.’s (2004) school based study in Korea, asked school students about their perceptions of why they did not obtain sufficient sleep. The two most often self-reported reasons for insufficient sleep were early school start times, internet and television use at night, followed by homework and attending night school. Gau and Soong (1995) reported that about 65% of their junior high sample complained of insufficient sleep, stating that the main reason for going to bed after 11 p.m. was due to exam preparation and homework, followed by watching T.V. or playing electronic games. For those who reported poor sleep, about 42% were not able to identify a reason for this, however, about 27% reported that tension and worry was the main cause of their poor sleep, followed by school problems, and personal or family issues. These findings provide an interesting perspective from adolescents as to what factors they believe impact negatively on their sleep. Little other literature was found that forwards the adolescent perspective.

5.5 Part-time Work

Increasingly, adolescents have become part of the casual work force as well as attending school. Rosa (1997) identified that young people have the job of attending school and completing homework, a task that he asserts is similar to an adult’s 40-hour working week. With the addition of part-time work he has likened this to adolescents having a 50 – 60 hour weekly school/work schedule. He suggests that due to these heavy schedules, young people may sacrifice sleep time and thus accumulate a sleep debt.

In a survey of US senior high school students, about half of the students held part-time jobs, with about 56% of these students reporting that they worked 20 hours or more per week (Wolfson, 2002). Wolfson contends that as adolescents progress through school to the senior levels, their participation in paid work increases dramatically, while participation in sport and extra-curricular activities decreases. Those students who worked 20 hours or more went to bed later, obtained less sleep, and were sleepier in class than those who worked less than 20 hours per week. They complained of having trouble staying awake in class and while doing homework, and reported more problem behaviours such as arriving late to school due to sleeping in. Furthermore, they also
reported higher use of caffeine, alcohol, tobacco and drugs. In a study by Allen (1992) later hours of employment were associated with later weekend bedtimes.

In Australia, a study with 138 school students (14 to 19 years) found that about 34% of the students were in employment and that they worked, on average, about 11 hours per week. Importantly, this study showed that students who were in paid employment reported lower attentiveness and cognitive engagement at school, and higher daily stress levels than those who were not in part-time employment (Garvin & Martin, 1999). Sleep parameters were not investigated in this study and it appears that little research has been conducted in to how adolescent work participation may influence sleep opportunity.

5.6 Increased Homework, Social Activities, Leisure Activities

Researchers such as Carskadon and colleagues have often commented that as adolescents move through the senior levels of high school there are increased academic demands, involving more homework and study outside of school hours, continued involvement in sports and other extra-curricular activities, as well as increased social activity that all contribute to very busy schedules for this age group, resulting in decreased time available for sleep (Carskadon, 1999; Millman, 2005; Wolfson & Carskadon, 1998). Wolfson (2002) reported that senior high students spent about 7 hours doing homework. In contrast to this, one Australian high school recommends that at least 20 hours of study outside of school hours is required in the final years of schooling in order to achieve academically (Balwyn High School, 2005), while research in Japan linked shorter sleep duration in 15 to 18 year olds (n = 3,478) with longer study hours and longer travel times to school (Tagaya et al., 2004).

Surveys have indicated that involvement in extra curricular activities ranges from about a quarter of surveyed students in the US (Carskadon, 2002), to about 63% of students in a Brazilian study (Andrade et al., 1993), with around one-third of the US students reporting involvement in sports (Carskadon, 2002). Carskadon (1999) also points out that many teenagers have televisions, CD players, computers with internet access, and phones in their bedrooms, and that these factors have not been comprehensively investigated in relation to their contribution to delaying bedtimes in adolescents. However, some research has been conducted indicating that these media
have a detrimental affect on sleep times for adolescents. Andrade et al. (1993) reported that adolescents in their survey watched, on average, about 3 hours, 30 minutes of television per night. Johnson, Cohen, Kasen, First, and Brook (2004) longitudinally investigated television viewing and sleep problems in a community-based sample of 759 mothers and their children. Interviews were conducted at early adolescence (mean age, 14 years), middle adolescence (mean age, 16 years) and young adulthood (mean age, 22 years). Those adolescents who watched 3 hours or more television per day experienced a significant level of sleep problems in young adulthood. Van den Bulck (2004) surveyed 15 schools in Flanders, reporting that adolescents who had televisions or computers in their rooms went to bed later, obtained less weekday sleep, and complained of higher levels of tiredness than those who did not have these appliances in their room. Going out socialising also was associated with shorter sleep times in this study of 2,546 adolescents.

In addition, mobile phones have been identified by Van den Bulck (2003) as a disturbing influence on the quality of sleep in adolescents, with over half of the 16 year olds in this survey reporting that they had been woken up at night by incoming calls on their mobile phone. Apparently, some of the parents of the children involved in the study told the researcher that their teenagers took their phones into bed with them.

While the adolescent sleep literature has not specifically studied social activities and habits, some of the reported results certainly imply that on weekends school aged adolescents enjoy social activities that extend into the early hours of the morning. Some results indicated that significant proportions of students go to bed at 2:30 a.m. or later (Allen, 1992) with other studies reporting later bedtime delays of about 2 hours on weekends (Gianotti et al., 2002; Wolfson & Carskadon, 1998).

Clearly, the array of distractions that adolescents can involve themselves in are many, and these activities in their own right may place constraints on the time available for sleep if adolescents delay their bedtimes due to participation in these. With recent findings that link light exposure, and tentatively, auditory stimuli, with the nocturnal timing of melatonin and core body temperature, there might also be an interaction between the behavioural habits that involve cognitive activation, light and sound (such as television and computer use at night) and the entrainment of biological processes that
control sleep (Goel, 2005; Harada et al., 2004; Higuchi et al., 2003). These factors, coupled with relaxed monitoring of activities by parents, could result in severely compromised sleep times.

5.7 School Start Times

School starting times have been demonstrated to be a determining factor in the amount of sleep obtained by young people. As discussed in Chapter One, differences have been noted in adolescent sleep patterns between school days and weekends, and school days and holidays, indicating that school starting times synchronise the wake up time for students to a much earlier time than they show a preference for on weekends and holidays (Hansen et al., 2005; Szymczak et al., 1993; Wolfson & Carskadon, 1998; Yang et al., 2005). School starting times for senior students are not uniform, with some starting times in countries such as Korea, Brazil, and the US reported to be as early as from 7 a.m. to 7:40 a.m. (Andrade et al., 1993; Wolfson & Carskadon, 1998; Yang, 2005), about 8 a.m. for Germany, and around 8:30 a.m. for France and Italy. Australian secondary schools generally start at about 8:30 a.m., but this varies between schools and regions.

Some studies have directly investigated the effect of school starting times on the sleep patterns of adolescents. In one project Carskadon, Wolfson, Acebo, Tzischinsky, and Seifer (1998) tracked 25 adolescents who were transitioning from junior high school to senior high. This required them to begin school at 7:20 a.m., which was one hour earlier than the start time at junior high. Sleep times were recorded using actigraphy, and daytime sleepiness was measured by the multiple sleep latency test (MSLT), which measures sleep tendency in 20-minute trials throughout the testing period. This revealed that students did not change their sleep onset times and that the average amount of sleep during the school week therefore fell from over 7 hours to 6 hours and 50 minutes, with increased levels of daytime sleepiness. These times were well below what these researchers had established as adequate for optimal alertness in previous work (e.g., Carskadon et al., 1980).

Of particular interest was the finding that 12 students whose circadian timing had moved to a later phase in senior high were classed as being markedly impaired on the MSLT. They fell asleep in an average of 3.4 minutes when tested at 8:30 a.m., and
demonstrated a narcoleptic sleep pattern where REM (rapid eye movement) sleep occurred before non-REM sleep. Carskadon et al. (1998) asserted that the later onset of melatonin secretion in these students compared to the others in the group, and the REM sleep episodes, were evidence of a mismatch between their circadian rhythm and school start. Their natural sleep pattern was such that they would still be asleep if given the opportunity, at the time that they were required to be at school.

Due to this research, and along with other work by Carskadon and her colleagues, the starting times of schools in the US has been hotly debated. Research has been conducted within the Minneapolis School District where a decision was made to change the starting time of seven high schools to 8:40 a.m. and finish at 3:20 p.m., in order to better align school times with the biological sleep patterns of adolescents. Prior to the change, classes began at 7:15 a.m. and concluded at 1:45 p.m. The School Sleep Habits Survey (Wolfson & Carskadon, 1998) was administered to a stratified random sample of 9 to 12th. graders (n = 471). The survey was also administered to a sample of students (District B, n = 599) in a comparable school district that had not changed school start times.

Wahstrom, Wrobel and Kubrow (1998) reported several findings from this study that indicate the importance of sleep times in the adolescent population. The Minneapolis group obtained an average of one hour more sleep per night (mean of 7 hours, 46 minutes) than early start time students, a gain of, on average, 5 hours per week. This finding supported previous research suggesting that around 11 p.m. is when adolescents naturally feel sleepy (Tzischinsky et al., 1995). It also did not support some expectations that the Minneapolis group would go to bed an hour later.

Improved attendance rates were observed, as well as improvements in alertness while at school and studying, with 51% of teachers noticing that students were more alert and ready to learn. There were fewer reports of lateness due to oversleeping, and less days home due to sickness. Also of interest is that the Minneapolis group reported higher academic achievement, which could be speculated to be due to the extra hour of sleep. Research conducted by Allen (1992) also supports this view that students who attend a school with an earlier starting time obtain less sleep. Additionally, this study noted reports of lower sleep quality and longer weekend oversleeps. This American
research indicates that adolescents who have early starts do not tend to adjust their circadian phase in order to gain an adequate amount of sleep. The research has shown that, on the contrary, some students started early despite having very delayed circadian patterns. Carskadon et al.’s (1998) work demonstrated the negative consequences of this with some students experiencing excessive sleepiness during the day. To date, there is no comparable Australian data, although school starting times have not been such a contentious issue, with starting times generally at around 8:30 a.m.

5.8 Summary of External Factors Affecting Adolescent Sleep

Although little empirical research has been conducted into all of the factors that have been forwarded as influences on adolescent sleep patterns, it seems apparent that many aspects of a young person’s life, such as school start times, school commitments, extra-curricular activities, part-time work, leisure and social activities, combined with the internal factors of a biologically mediated phase delay and individual differences in morningness-eveningness, impact significantly on the sleep/wake cycles of this group. Later school starting times appear to be more in keeping with the rhythm and preference of adolescents, with students at earlier starting schools reporting sleep duration times suggesting that they are more sleep deprived than students from later starting schools. Presently, there is no data available from Australia to contribute to the adolescent sleep area. While there are significant cultural similarities between the US and Australian lifestyles, and similar concerns about the impact of factors such as part-time work, the media, internet, and mobile phone use on the well-being of young people, there are significant differences also that could result in very different sleep/wake patterns in Australia. The most important of these is school starting times, with Australian schools generally starting about one hour or more later than those in the US. It remains to be seen whether this results in longer sleep times, as has been demonstrated in a few studies in the US with later starting schools.
Chapter Six: The Consequences of Insufficient and Poor Quality Sleep for Adolescents

6.1 Overview

This chapter presents the literature that has explored the consequences of insufficient, or poor quality sleep for adolescents, and expands on the brief discussion previously in Chapter 4.7 about some of the apparent consequences and correlates of poor sleep quality and habits in regards to morningness/eveningness. First, the findings from experimental sleep deprivation studies in adults, children and adolescents are forwarded to give an outline of the breadth of negative consequences that have been identified. Then the naturalistic studies that have been conducted with school-based adolescents are discussed, showing broader outcomes than the experimental studies in terms of everyday functioning. Although correlational, these studies build the argument that insufficient sleep due to many factors, both internal and external to the individual, impacts on day-to-day life in a number of deleterious ways for adolescents.

Some evidence is then presented arguing that subjective perceptions of sleep quality might be more important than sleep quantity in predicting negative functioning and performance outcomes. Finally, the similarities between depression and sleep deprivation are presented, with a discussion on the work suggesting that insufficient sleep could be a causal factor in the development of this disorder. Collectively, the evidence presented in this section provides persuasive arguments for the importance of sleep in the day-to-day lives of adolescents.

6.2 Sleep Deprivation Studies

The specific function of sleep has been described as a mystery despite the advances and considerable research conducted on this topic (Dahl & Lewin, 2002). Restorative processes that involve the replenishment of neurotransmitters are hypothesized to occur, with the suggestion that REM sleep facilitates the development and maturation of the brain and sensory systems of young humans. Recent evidence confirms that the development of the prefrontal cortex is further refined during adolescence, and does not attain an adult profile until the third decade of life (Giedd et al., 1999). Despite the gaps in scientific knowledge on the definitive reasons for the
human body to sleep, it seems abundantly evident that humans cannot function adequately in daily life without sufficient sleep (Hobson, 1995; Siegel, 2003).

In adults, insufficient sleep and sleep deprivation have been associated with decreased verbal and arithmetic skills (Drummond et al., 2000), decreased effort (Engle-Friedman et al., 2003), sleepiness, impaired cognitive speed and accuracy, performance decrements, short term memory problems, slower reaction times, impaired executive functioning, poor productivity, accidents, lowered mood, and loss of some forms of behavioural control (Carskadon & Dement, 1979; Dinges et al., 1994; Dinges et al., 1997; Lamond & Dawson, 1999; National Institute of Health, 1997; Nilsson et al., 2005; Philip et al., 2003). In addition, sleep deprivation has been associated with a reduction in human immune responses (Irwin et al., 1996), and impaired metabolic and endocrine function (Spiegel, Leproult, & Caulter, 1999). Furthermore, recent studies have shown that sleep is an important factor in relation to verbal memory retention, learning and memory consolidation, and the processing of declarative knowledge (Cipolli, Fagiolli, Mazzetti, & Tuozzi, 2005; Clemens, Fabo, & Halasz, 2005; Walker & Stickgold, 2004).

Studies with children and adolescents have found that low sleep times in children have also been associated with aggressive and delinquent behaviour, as well as social problems (Aronen, Paavonen, Fjallberg, Soininen, & Torronen, 2000), inattentive behaviours, and loss of concentration (Fallone, Arnedt, & Carskadon, 2001), impaired verbal creativity and abstract thinking (Randazzo, Muehlbach, Schweitzer, & Walsh, 1998), daytime sleepiness (Andrade et al., 1993; Carskadon et al., 1998; Wolfson & Carskadon, 1998), lower grades at school (Wolfson & Carskadon, 1998), and obesity (Gupta, Mueller, Chan, & Meninger, 2002). These studies have provided ample evidence that sufficient sleep is required for young people to adequately attend to and engage with new material at school, to retain and recall information, to solve problems, and generally to perform academically and interpersonally.

Sleep debt, generally defined as chronically obtaining less sleep than is required by the individual, has been shown to be cumulative in nature. Studies where sleep duration was restricted over several nights demonstrated continued decrements in daytime performance, neurobehavioural alertness, and mood. It appears that two full
nights of recovery sleep are subsequently needed to return to normal daytime performance and alertness levels (Carskadon & Dement, 1981; Dinges et al., 1994; Dinges et al., 1997; Van Dongen, Rogers & Dinges, 2003).

6.3 Sleep and Daytime Functioning in Adolescents

Investigations into the consequences of insufficient sleep for adolescents have mostly been conducted in naturalistic, school-based studies. These have tended to focus on the daytime functioning of adolescents at school, and results have been based on self-report surveys exploring the relationship between sleep habits, daytime sleepiness, mood, substance use, and grades. One of the most consistent findings in the adolescent literature is the link between lower sleep times and increased daytime sleepiness reported by this group, with some evidence that this complaint increases as adolescents progress through school to the senior levels (Andrade et al., 1993; Arakawa et al., 2001; Bearpark & Michie, 1987; Carskadon et al., 1983; Carskadon et al., 1998; Reid et al., 2004; Mello, Louzada, & Menna-Baretto, 2001; Takemura et al., 2002; Yang et al., 2005).

Andrade et al. (1993) found that the students in their study who complained of morning sleepiness also tended to sleep in later on weekends. Andrade et al. concluded that the morning sleepiness reported by students corresponded to the time that they would usually still be asleep on weekends. Gianotti et al. (2002) found that daytime sleepiness was predicted by an evening circadian preference, sleep problems, irregular sleep patterns and higher reports of anxious and depressed mood. Similarly, in a research design that utilised interviews and clinical examination in a follow up to a previous survey, chronic daytime sleepiness was predicted by difficulty falling asleep, night waking, use of medication, frequent use of alcohol, and depressive symptoms (Saarenpaa-Heikkila et al., 2001).

In regards to the daily consequences of feeling sleepy, Dahl (1999) has suggested that the still developing prefrontal cortex of the adolescent brain is most affected by sleep deprivation, with implications for executive functioning including information processing, decision making, goal-setting, and controlling emotional and behavioural responses. Dahl goes on to explain that while students may be able to remain fairly alert during stimulating activities, the full effects of sleepiness are felt
when in situations of low stimulation, such as sitting in class, reading or doing repetitive tasks. Furthermore, Dahl suggests that tiredness could result in feelings of demotivation, an unwillingness to tackle difficult tasks, or even decrements in the cognitive capacities necessary for abstract reasoning and problem solving. Clearly, learning and absorbing new information would be compromised in students who experience such difficulties and deficits in class. In light of his clinical observations, Dahl goes on to suggest that insufficient sleep contributes to emotional changes, such as lowered mood, or mood lability, irritability, impatience, aggression and low tolerance for frustration. Some empirical evidence supports these observations, with shorter sleep duration found to be associated with aggression and conduct problems (Wolfson et al., 1995). While more extensive empirical studies are warranted in regard to the neurobehavioural outcomes of insufficient sleep, some evidence from naturalistic studies has been forwarded that links insufficient sleep with a number of important outcomes for adolescents.

For example, Wolfson and Carskadon’s (1998) research with 3,120 high school students utilised the School Sleep Habits Survey consisting of a two-week retrospective sleep log, along with measures of daytime functioning and grades. Students were categorised as short sleepers if they obtained less than 6 hours, 45 minutes of sleep on school nights, and long sleepers if they obtained over 8 hours, 15 minutes. The short sleepers reported that they tended to experience more impaired daytime functioning, lower mood, and lower academic results. More irregular sleep schedules (later weekend bedtime delays or longer weekend oversleeps) were also found to contribute to this.

Daytime functioning was assessed by the Sleep/Wake Problems Behaviour Scale, the Sleepiness Scale, and the Depressed Mood Scale. The Sleep/Wake Problems Behaviour Scale asked about daytime behaviours such as being late for class due to sleeping in, feeling sleepy during the day, and falling asleep in class. This scale also assessed aspects of nocturnal behaviour and sleep, with items asking about staying up until the early hours of the morning, and difficulty getting off to sleep, thus not clearly delineating between daytime functioning and nocturnal sleep patterns. The Sleepiness Scale comprised items about feeling sleepy in class, while doing homework, while playing games, or while talking with another person etc., similarly to some questions in the Sleep/Wake Problems Behaviour Scale. Although none of these items addressed
specific cognitive, attentional, or irritability problems, they indicated behavioural aspects of insufficient sleep, such as being late for class, or falling asleep doing homework, which indirectly implied serious attentional and concentration deficits.

The Depressed Mood Scale (Kandel & Davies, 1982) was utilised to assess mood. However, one of the six items asked about having trouble going to sleep or staying asleep. This item was similar to an item about difficulty getting off to sleep in the Sleep/Wake Problems Behaviour Scale, and thus, aspects of nocturnal sleep difficulties were common factors in the dependent variables in this study, and the grouping of the independent variables. Consequently it is not clear whether there was an unequivocal link between poorer sleep habits and the cognitive and affective symptoms of depressed mood.

In regards to grades, students who obtained self-reported lower grades (C, D, or F grades) tended to obtain less sleep, go to bed later, and report greater variability between week and weekend sleep patterns than students who obtained higher grades. Students who obtained A’s and B’s tended to have longer sleep duration, more regular sleep patterns (less variability between week and weekend patterns), and generally tended to go to bed earlier and get up earlier on weekends. Wolfson and Carskadon (1998) summarised their findings with short vs. long sleepers as indicating that insufficient sleep and irregular sleep patterns affect an adolescent’s ability to perform and function adequately during the day, with negative behavioural and academic consequences. Some of these findings were replicated in a more recent study also using the School Sleep Habits Survey in the US, however, there was no evidence that the sleep irregularity measure of weekend oversleep was associated with daytime functioning, nor was there evidence of shorter sleepers attaining lower grades (O’Brien & Mindell, 2005).

Further investigating the School Sleep Habits Survey data (Wolfson & Carskadon, 1998), Acebo and Carskadon (2002) assessed the importance of school-night sleep duration and irregular sleep patterns on a number of daytime functioning variables including grades, depression, days home from school, injuries, injuries while using alcohol or drugs, morningness-eveningness, and sleep quality (measured as satisfaction with sleep). Sleep duration and regularity of sleep patterns were revealed to
independently predict different aspects of daytime functioning in the multiple regressions performed for this study. School night sleep time was demonstrated to contribute uniquely to depression, sleep quality, morningness-eveningness, and daytime sleepiness. Lower sleep duration was associated with eveningness, which was characterised as indicating delayed sleep phase and daytime functioning problems like having trouble getting up in the morning for school, and sleeping in as a consequence of this.

On the other hand, the sleep pattern regularity measure of bedtime delay significantly predicted grades, days home from school and injuries associated with drug and/or alcohol use. For both predictors the effect size of the relationships were small, and the directions of the associations were such that lower sleep times and more irregular sleep patterns were related to more negative outcomes in daytime functioning. It is noteworthy that sleep quality was used as a dependent variable in this study, and was not used along with sleep duration measures as a predictor for the outcome measures of mood, daytime functioning or grades. Consequently this study did not explore whether subjective perceptions about sleep quality were as important, or more important than more objective measures of sleep duration.

Wolfson and Carskadon’s (1998) findings have been paralleled by Gianotti et al. (2002), who used chronotypes to categorise the 6,631 students in their study, rather than short versus long sleepers. Nevertheless, they found that evening types tended to have lower sleep times than the morning types during the school week, and reported similar negative daytime functioning outcomes for the evening types to those found for short sleepers in Wolfson and Carskadon’s study. As discussed in Chapter 4.7, the evening types obtained less sleep on school nights, reported lower subjective sleep quality, more sleep/wake behaviour problems, more attention problems, more injuries, more negative mood and anxiety symptoms, tended to use more substances in the form of caffeine, tobacco, and alcohol, and obtained lower grades than the morning types. Regression analyses were conducted in this study to ascertain the relative importance of the sleep and circadian preference variables in relation to daytime functioning, mood and academic performance outcome measures.
Daytime sleepiness was significantly predicted by higher levels of substance use, more problematic sleep/wake behaviours, feelings of depression and anxiety, evening preference, and irregular sleep patterns. Emotional problems (depression and anxiety symptoms) were significantly predicted by female gender, more sleep/wake problems, less sleep duration and evening preference, while circadian type, substance use and male gender were significant predictors of poor school grades. Taking the results together, the study seems to suggest that circadian preference may account for those students who have late bedtimes, and do not obtain enough sleep at school time, and additionally provides some evidence that the quality of sleep may be an important predictor also in the outcomes of mood, functioning, and subsequently on academic achievement.

It was concluded from these findings that a preference for eveningness was not conducive for adapting to school schedule, and it could be speculated that this preference is an important mediating factor in adolescent daytime performance and mood. Gianotti et al.’s findings with adolescent chronotypes were also consistent with Medeiros et al.’s (2001) study with 36 morning and evening type medical school students where significant correlations were demonstrated between sleep duration, sleep irregularity, sleep quality, and academic performance. Authors have proposed that the pathway from sleep to poor academic performance is due to impaired daytime performance, where students have difficulties concentrating and learning in class due to insufficient or poor sleep (Medeiros et al., 2001; Wolfson & Carskadon, 1998).

### 6.4 Sleep and Substance Use

Substance Use is included in the School Sleep Habits Survey (Wolfson and Carskadon, 1998) and as noted in the section above, has been used by Gianotti et al. (2002) as a predictor of daytime functioning in their school based study, while injuries as a result of alcohol or drug use was used as an outcome measure in the study by Acebo and Carskadon (2002). Although the inclusion of substance use in these studies indicates that it is seen as an important factor to be considered in relation to adolescent sleep, to date there has been little discussion about the nature of this relationship. O’Brien and Mindell (2005) have identified this area as being one requiring further study, hypothesising that adolescents may be more prone to risk taking behaviours (including alcohol, drug, and tobacco use) due to the impact of insufficient sleep on
their cognitive and emotional functioning. They assert that support for this hypothesis has been provided with their findings that adolescents who obtained insufficient sleep tended to report more risk-taking behaviours, which included alcohol and tobacco use.

Other research with adolescents has revealed that those who smoke tend to sleep less than non-smokers (Townsend, Wilkes, Haines, and Jarvis, 1991) and that adolescents who experience sleep problems like difficulty initiating and maintaining sleep are more likely to report substance use (tobacco, alcohol and stimulant use) than those who do not experience sleep problems (Bailly, Bailly-Lambin, Querley, Beuscart, & Collinet, 2004). However, it appears likely that substance use is a reciprocal factor in regards to sleep and daytime functioning. Tynjälä, Kannas, and Levälahti (1997) report that perceived tiredness, sleep habits and substance use (alcohol, tobacco and coffee) were significantly interrelated, and that this relationship was stronger for boys than girls in their study of 15-year-old adolescents in Finland. Bootzin and Stevens (2005) suggest that the experience of sleep difficulties, and the subsequent problems with daytime functioning and mood may prompt some adolescents to self-medicate with substances such as alcohol, and that substance use is additionally interrelated with mental health problems such as anxiety and depression. Consequently, adolescents may use substances to stimulate alertness and functioning during the day, due to insufficient sleep, and may use alcohol in order to self-medicate sleep difficulties and low mood. Substances such as tobacco, alcohol, and caffeine could reasonably be expected to impact on the timing, duration, and quality of sleep, further exacerbating problems with functioning the next day (Bootzin & Stevens, 2005; Roehrs & Roth, 2001; Shilo et al., 2002).

6.5 Sleep Quality Versus Sleep Duration as Predictors of Daytime Functioning

Very few studies have investigated the importance of perceived sleep quality as opposed to reported sleep duration in regards to daytime functioning in adolescents. Studies with adults suggest that measures of sleep quality are more strongly related to health and well-being measures than sleep quantity, although, as noted previously, these two concepts overlap to some degree (Gray & Watson, 2002; Pilcher et al., 1997; Pilcher & Ott, 1998). These studies have used the PSQI as the measure of sleep quality, which includes satisfaction with sleep duration as well as subjective ratings of quality and occurrence of sleep difficulties, and suggest that perceptions of sleep problems and
dissatisfaction with sleep might be more strongly predictive of daytime measures of mood, fatigue, daytime sleepiness, and subjective feelings of health than sleep duration.

A study with 449 children and young adolescents (10 to 14 years) by Meijer et al. (2000), reported that subjective sleep quality, as measured by four items about sleep latency, night waking, and subjective ratings of quality, was associated with school functioning, and in particular, achievement motivation at school, but sleep duration was not a predictor of these measures. Students who reported higher quality of sleep tended to be more motivated to achieve at school. However, sleep times for these children ranged from between 8 hours, 24 minutes to 12 hours, so it could be argued that effects of sleep deprivation would have been difficult to detect in such a well-rested group. Additionally, most of these children were pre-pubescent and as such, these results may not be applicable to an older adolescent sample.

Research investigating sleep problems rather than sleep duration suggests similar negative consequences or correlates to those discussed in regards to insufficient sleep. For example, in Morrison et al.’s (1992) longitudinal survey of 943 adolescents (assessed at age 13 and 15 years), sleep problems were found to be associated with more inattentive, anxious, depressed and conduct disordered behaviours than those who had few, or no sleep problems. Sleep problems were also associated with DSM-III disorders (APA, 1987), and the problems were defined as: having difficulty falling asleep; waking in the night; early morning waking; needing more sleep than previously; and an item that inquired whether the participant experienced any other problems with sleep.

In reviewing this literature it has been difficult to gain a clear perspective on how sleep quality and quantity interact in regards to the negative consequences that have been identified, particularly as quantity and quality of sleep are such interrelated concepts. The quality of sleep has been investigated in different ways in studies with adolescent subjects. In the School Sleep Habits Survey, sleep quality has been variously assessed. Acebo and Carskadon (2002) have used two items from the Sleep/Wake Behaviour Problem Scale asking about satisfaction with sleep, while it appears that Gianotti et al. (2002) utilised yet another item from the School Sleep Habits Survey that asked for the participants to rate themselves as good or poor sleepers. Difficulty falling asleep, which is used as part of assessments of sleep quality in instruments such as the
PSQI (Buysse et al., 1989), is assessed as part of the Sleep/Wake Problems Behaviour Scale in the School Sleep Habits Survey. It is possible that more clarity could be found around these issues of adolescent functioning by investigating how sleep quality, defined as nocturnal sleep problems and subjective ratings of sleep satisfaction, relates to daytime functioning.

Nonetheless, while there seems to be some debate about the relative importance of sleep quantity versus subjective quality as a predictor of daytime functioning variables, taken together these studies provide compelling evidence that insufficient or poor quality sleep is associated with a number of negative factors in the daily functioning of adolescents.

### 6.6 Intervention Studies

With early school schedules being identified as an important reason for insufficient sleep in adolescents it has been difficult to design effective interventions as this factor is largely inflexible. Notably, however, one school district in the US was persuaded to change school start times for senior school students despite the enormous barriers of changing transport and teaching timetables to do so. As discussed in Chapter Five, Wahlstrom et al. (1998) conducted research for this school start time project, using the School Sleep Habits Survey. This work showed that by delaying school start times by one hour, students obtained about one hour additional sleep than the schools that remained on the early start time. Significant improvements in attendance rates, reported illness, mood, daytime alertness, and academic achievement were observed, prompting Wahlstrom et al. to comment that these effects appeared to be due to obtaining more sleep. They contended that later start times were better for students - they slept more, felt better, and performed better than the students at the early starting schools, providing further evidence that sleep is an important, and perhaps often overlooked factor, in day-to-day performance and well-being.

One recent study has also reported on an intervention that was designed utilizing bright light therapy in the morning in an attempt to shift sleep phase and improve the outcomes of mood, vigour and cognitive performance in 60 senior school students (Hansen et al., 2005). This study, mentioned in Chapter Two, investigated the impact of school schedule on sleep duration, by comparing sleep patterns at holiday and school
term time. Students were shown to lose up to 2 hours sleep per night once school term started, demonstrating considerable impact of school schedules on sleep duration. During school term the students were divided between a placebo and light therapy group, and performance and mood testing was conducted three times a day during the testing periods. No improvements were noted over time in sleep times or the cognitive or mood measures in either group, except that all students tended to perform better in the afternoon as compared to morning, which these researchers suggested as demonstrating a circadian phase delay. Hansen et al. pointed out that an important limitation of their research was that they failed to collect mood and performance data during the holidays to use as a baseline measure in order to assess change in these variables that may be due to school schedule. Data were not presented that specifically investigated the link between sleep deprivation and mood and cognitive performance.

A study design that compares holiday versus school term time appears to provide a good opportunity to collect naturalistic baseline data about mood and functioning in the holiday period, when students are relatively relaxed and more likely to be self-selecting their sleep cycles, and to use this to compare to data collected during school time. This may then be used to ascertain the impact of school schedule on outcome variables as well as sleep patterns, allowing investigation of the links between sleep variables and outcome variables over time as well.

6.7 The Link Between Sleep and Depression in Adults and the Implication for Adolescents

Increasingly, the mental health of young people in Australia has been of concern. An epidemiological study reported that the prevalence rate for depressive disorders in Australian adolescents aged 12 to 17 years was 4%, with no gender differences in prevalence rates reported (Rey, Sawyer, Clark, & Baghurst, 2001). These results were established by using diagnostic interviews based on DSM-IV criteria (APA, 1994). However, many more young people experience depressive symptoms, with one in four teenagers reporting that feelings of depression were their main health concern in a recent Victorian study (Waters et al., 1999). Girls in the sample were 20% more likely than boys to report feelings of depression. The National Health and Medical Research Council (1997) has suggested that these feelings of unhappiness can affect a young person’s ability to cope, and may be a risk factor for clinical depression.
Until quite recently the symptoms of depression, such as social withdrawal, low mood, irritability, deteriorating academic performance and sleep problems, were not recognized, and often regarded as a typical adolescent “phase”.

It is well recognized that sleep and major depressive disorder (MDD) are highly interrelated. The normal patterns of sleep and its stages are often altered in people with MDD, and disturbed sleep, particularly insomnia, is regarded as one of the hallmarks of this disorder (Berger, van Calker, & Riemann, 2003; Ford & Kamerow, 1989; Frisoni et al., 1992; Liljenberg, Almwwist, Hetta, Roos, & Agren et al., 1989; Motivala, Sarfatti, Olmos, & Irwin et al., 2005; Rotenberg et al., 2002; Spoormaker & van den Bout, 2005; Szuba, 2001). Depressed mood and/or anhedonia must be present to diagnose MDD in DSM-IV-TR, along with at least four more symptoms, which can include sleep disturbance (APS, 2000). Szuba (2001) argues that sleep disturbance is the most common symptom experienced by individuals, and that it could be speculated that disturbed sleep contributed to the other symptoms of MDD, such as difficulty thinking, concentrating, making decisions, changes in psychomotor activity, and lethargy. Research that has manipulated the sleep/wake cycle in depressed patients has further demonstrated the strong bi-directional relationships between sleep and depression, with findings that partial sleep deprivation may alleviate depressive symptoms (Berger et al., 2003; Giedke, Klingberg, Schwarzler, & Schweinsberg, 2003; Rotenberg, 2003).

The link between sleep and depression has been explored in a well-known longitudinal study by Ford and Kamerow (1989), that has been described as one of the most rigorous epidemiological studies on sleep problems and psychiatric disturbance due to the use of a household probability sample of 7,954 subjects, structured interviewing, and follow-up (Reynolds, 1989). The study revealed that adults who reported sleep disturbances in the initial interview were more likely to have developed depression by the next annual interview, compared with those who had not reported any difficulties, or whose sleep problems had resolved. Excessive daytime sleepiness, which was more prevalent in younger people aged 18 to 25 years, was also found to be associated with psychiatric problems, such as depression. Ford and Kamerow suggested that sleep disturbance may be an early symptom of depression, or, provocatively, that it may be the cause of depression. These authors went on to argue that early intervention for sleep difficulties may prevent psychiatric illness, such as depression.
Recently in Australia, Morawetz (2000) conducted an intervention study and reported that for many people suffering from insomnia and depression, treating the insomnia successfully with cognitive behavioural therapy resulted in an improvement in depression. His sample of 86 people ranged in age from 16 to 88 years. More than half (57%) of those who were depressed before the treatment were no longer depressed at follow up. Depression was measured by the Beck Depression Inventory (Beck & Steer, 1987). An additional 13%, while still depressed, had a reduction of at least 40% in their depression score. However, some of the sample were using anti-depressants and sleeping medication when inducted into the research project. These results are interesting and add to the notion that sleep deprivation in the form of insomnia may be a causative factor in some cases of depression. However, more stringent criteria regarding subjects on medication would need to be used in further studies.

Not surprisingly, many studies have noted an important association between disturbed sleep in adolescents and depression (Choquet & Menke, 1987; Kirmil-Gray, Eagleton, Gibson, & Thorenson, 1984; Montgomery, 1983; Roberts et al., 2001; Vignau et al., 1997). Morrison et al. (1992) assessed sleep problems amongst over 900 adolescents at age 13 years and again at 15 years, finding that sleep problems were often associated with DSM-III (APS, 1987) disorder, particularly depression. Dahl and Lewin (2002) assert that difficulty getting off to sleep is common in depressed adolescents, more so than early morning waking which is seen more in adult depression. Dahl et al. (1996) demonstrated that depressed adolescents took longer to fall asleep at home and in laboratory conditions compared to non-depressed adolescents, and have suggested that the first sign of sleep disturbance associated with depression is difficulty falling asleep. Dahl et al. suggest that these findings, taken together with the findings for adult depression by Ford and Kammerow (1989) imply that impaired sleep onset may precede the onset of depression in formerly non-depressed adolescents and adults.

Further literature has proposed that disturbances in circadian rhythms may be a causal factor in the development of affective disorders such as major depression. There is evidence that manipulating the circadian system by imposing sleep deprivation regimes, phase advances in sleep times, and phototherapy impact on the symptoms of depression, implicating circadian rhythms in the disorder (Naylor & King, 1993; Szuba, Yager, Guze, Allen, & Baxter, 1992; Wiegand, Lauer, & Schreiber, 2001). Evidence
was presented previously in Chapter Four supporting the view that adolescents undergo a later phase shift, that is mediated by puberty, with researchers proposing that this makes young people particularly susceptible to circadian rhythm disturbances and sleep problems, particularly getting off to sleep, resulting in insufficient sleep (Carskadon & Acebo, 1997; Carskadon et al., 1993; Laberge et al., 2001). In addition, individual circadian preference has been forwarded as an important factor that may mediate adolescent sleep patterns, adding another layer of vulnerability for adolescents who are distinctly evening types. It has been proposed that the higher levels of emotional problems found in evening type adolescents may be attributable to their chronic sleep deprivation, and erratic sleep patterns (Gianotti et al., 2001).

In experimental sleep loss studies, mentioned in Chapter 6.2, a more causal relationship has been found between restricted sleep and lowered mood. In one study, Carskadon and Dement (1979) found that six undergraduates reported significantly lower mood after two nights of sleep loss. Their scores returned to baseline after two recovery nights of sleep. In another study, Carskadon et al., (1989) found that when students were asked to reduce their habitual sleep by two hours over five consecutive nights, they reported decrements in their mood during the reduced sleep period on both daily and weekly depressive mood scales.

Depressed adolescents have been described as individuals who have difficulties getting off to sleep, tending to sleep until late, have trouble getting out of bed in the morning, are unwilling to go to school, complain of daytime sleepiness, and tend to have pronounced phase delays in their sleep/wake schedules (Dahl & Lewin, 2002). These observations have many similarities to the findings of the school-based studies that have been presented so far, where insufficient sleep or evening preference was found to be associated with problems getting off to sleep, later bedtimes, increased daytime sleepiness, irregular sleep patterns, and lowered mood (Carskadon, Seifer, & Acebo, 1991; Gianotti et al., 2002; Wolfson & Carskadon, 1998; Wahlstrom et al., 1998). These similarities have prompted some researchers to suggest that differentiating between chronic sleep deprivation and depression in young people may be problematic, as many factors associated with these are common to both (Dahl & Lewin, 2002; Gianotti et al., 2002; Wolfson & Carskadon 1998). This is an area
deserving of further research, wider education, and implementation of intervention strategies in the adolescent population.

6.8 Summary of the Consequences of Insufficient and Poor Quality Sleep

Many consequences of insufficient and poor quality sleep in the adolescent population have been identified, although much research has been correlational, and causality cannot be established in naturalistic school based studies. Results from experimental studies show that sleep restriction can result in impairments in several domains in adults, children and adolescents. Sleep deprivation - and by inference, chronic sleep debt – has been shown to impair cognitive, behavioural, physiological, and emotional aspects of functioning. In naturalistic studies shorter sleep times, poor sleep habits and quality of sleep have been associated with a number of measures of day-to-day functioning in adolescents, such as sleepiness during school, inattentiveness, behavioural problems, lower academic grades, substance use, increased accidents, and depressive symptoms. However, some studies have tended to blur sleep variables with daytime measurements of behaviour and mood, providing opportunity to attempt to clarify these issues. Although teasing apart the reciprocal effects between mood and sleep disturbances remains a challenge for research, some literature has been presented supporting the view that there may be a causal link from adolescent sleep patterns to daytime functioning and depression, and that students with an evening preference might be especially vulnerable to more impaired functioning, lower mood and poor school performance due to insufficient sleep at school term. This lack of sleep appears to be mainly from late bedtimes, or not being able to sleep due to circadian rhythm factors, which prompt subjective feelings of poor sleep quality. While it is inconclusive whether the perception of poor sleep quality is a more important indicator of daytime problems than sleep duration, it seems most apparent from the literature reviewed that the consequences of insufficient and poor quality sleep are far-reaching for adolescents, with implications for their overall health and well-being.
Chapter Seven: Rationale and Hypotheses

7.1 Overview

In this longitudinal study one group of senior high school students were surveyed on sleep patterns, mood, daytime functioning and grades at two time points. The first survey (Time 1) collected information about these variables at holiday time, while the second survey (Time 2) elicited information about these variables at school term time (details of the surveys and methods are described in Chapter 8). The Time 1 data was used as a baseline measure for sleep patterns, mood, and daytime functioning as it referred to the last two weeks of the long summer holiday period when students did not have the stress and scheduling of school. The Time 2 data, collected at school time, was expected to show the impact of school scheduling on the variables. At both times, the dependent variables were the outcome measures of mood, daytime functioning, and grades. The independent variables of interest were sleep parameters (duration, irregularity, bed and wake times), sleep quality, circadian preference (also referred to as chronotype or morningness-eveningness), and gender. In this study, substance use was also used as a predictor of the outcomes, as in previous work by Gianotti et al. (2002).

Drawing on the literature reviewed in previous chapters, this section firstly describes the overall aims of the present study, followed by the specific hypotheses and research questions underpinning the project.

7.2 Aims

The review of the literature suggests that some consistent findings have emerged in this field. Several school-based studies have been conducted throughout the world, with many basing their survey instrument on the School Sleep Habits Survey (Wolfson & Carskadon, 1998). However, to date, comparable studies have not been conducted in Australia. Therefore, one of the primary aims of the present work was to provide some Australian data on the sleep patterns of adolescents in the final two years of school, using a survey instrument adapted from the School Sleep Habits Survey.

Another aim of the present study was to clearly differentiate between depressed mood and nocturnal sleep. In the School Sleep Habits Survey (Wolfson & Carskadon, 1998), the Depressed Mood Scale by Kandel and Davies (1982) was used to provide a measure of depressed mood. Items pertaining to sleep difficulties and anxiety were
included in this scale, so a different measure of depressed mood was used in the current study in order to differentiate between mood and sleep difficulties, by asking about the cognitive and affective symptoms of depression, without reference to sleep difficulties or anxiety.

The construct of daytime functioning was also expanded to include other day-to-day difficulties that have been identified in the literature to be a consequence of insufficient sleep. Accordingly, daytime functioning as measured here included daytime sleepiness, irritability with others, difficulty controlling emotions, clumsiness, tiredness, and problems with concentration, memory, and decision-making.

Sleep quality was also of interest in the current study, as previous work has suggested that this construct may be more important in predicting daytime functioning than sleep duration (Gray & Watson, 2002; Pilcher et al., 1997; Pilcher & Ott, 1998). It was operationalised in the current study to be compatible with the literature that characterizes sleep quality as comprising subjective satisfaction with sleep duration, subjective rating of sleep quality, as well as the identification of particular nocturnal sleep problems such as difficulty initiating and maintaining sleep (Buysse et al., 1989; Pilcher et al., 1997). In previous adolescent sleep studies difficulty initiating sleep has been included with problem sleep/wake behaviours such as falling asleep in class, or staying up very late (Gianotti et al., 2002; Wolfson & Carskadon, 1998), and sleep quality has been based only on satisfaction with sleep (Acebo & Carskadon, 2002), or one item asking the participant to rate themselves as a good or poor sleeper (Gianotti et al., 2002). The measures used are outlined in detail in the next chapter.

A further aim was to compare sleep patterns during school holidays, when students were less likely to be highly scheduled, with those of the school term, when school start times dictated morning wake-up times, and students were busy with school and other activities. Another objective was to compare holiday and school times in terms of the outcomes of daytime functioning, mood, and academic grades, and to investigate how these variables related to sleep patterns and circadian preference. While mood, daytime functioning, and academic performance outcome measures during school term have been investigated in terms of sleep patterns and chronotype (Acebo & Carskadon, 2002; Gianotti et al., 2002; Wolfson & Carskadon, 1998), and the impact of
school schedule on sleep patterns have been investigated by Hansen et al. (2005), Palazzolo et al. (2000), and Szymczak et al. (1993), the present research was intended to extend these studies, by tracking sleep patterns, mood, daytime functioning, and grades over time, and seeking to explore the impact of school schedules and individual circadian preference on these measures.

Another goal of the study was to provide data on the prevalence of specific sleep difficulties, both at holiday and school time, and to identify students’ subjective perceptions of the causes of sleep difficulties, or lack of sufficient sleep. Taking into account the proposals by Dahl et al. (1996) in Chapter Three, that emotional arousal due to worry contributes to sleep difficulties, the present study added this factor to the list of perceived factors affecting sleep that were included in the School Sleep Habits Survey (Wolfson & Carskadon, 1998).

Further extending the work conducted with chronotypes by Gianotti et al. (2002), the current study was designed to investigate the importance of circadian preference on sleep patterns and daytime functioning, grades, and mood at school time and holiday time. In particular, the aim was to investigate whether individual circadian preference mediated sleep times over and above the impact of school schedule. Furthermore, drawing on the causal pathways proposed by Cofer et al. (1999), Gianotti et al. (2002), and Medeiros et al. (2001), that were discussed in Chapter Four, and Dahl and Lewin (2002) in Chapter Three, another purpose of this current study was to model the proposed links from circadian preference to sleep variables, and in turn, to daytime functioning, mood, and grades, thus illustrating the hypothesised importance of chronotype as a mediating factor in adolescent sleep patterns and well-being.
7.3 Hypotheses and Research Questions

1. Holiday vs. School Term Sleep Patterns, Sleep Quality, Substance Use, Mood, Daytime Functioning, and Grades

(a) Based on the findings of differences between holiday and school sleep patterns by Hansen et al. (2005); Palazzolo et al. (2000); Szymczak et al. (1993) that were discussed in Chapter Two, it was expected that students would obtain significantly less sleep during the week at school time than they did at holiday time. It was also expected that students would wake up significantly earlier during school time than at holiday time, in order to accommodate the start of the school day, and would demonstrate greater variability between weekday and weekend sleep patterns during the school term than at holiday time.

(b) In addition to differences in sleep habits, the measures of sleep quality, substance use, daytime functioning, and mood, were explored over time to ascertain the effect of school schedule on these variables. Grades were also measured at the two time points, primarily to maintain consistency in the survey questions. As such, this provided a measure of the previous year’s academic achievements when assessed at holiday time, and a current assessment of grades when collected at school time.

2. Sleep Difficulties

The prevalence of particular sleep difficulties at both time points was investigated, along with level of satisfaction with sleep duration, and ratings of sleep quality. Also examined were the students’ own perceptions about the factors they believed to be responsible for their sleep difficulties or insufficient sleep.

3. Circadian Preference

(a) It was predicted, in line with previous findings discussed in Chapter Four, that no gender differences would be found in circadian preference scores.

(b) Based on findings by Gianotti et al. (2002), and Mercer et al. (1998), it was expected that evening preference would be associated at school time with greater
reported need for sleep, poorer sleep quality, later bedtimes and wake times, shorter school night sleep duration, higher sleep debt, longer weekend sleep time, and more irregular sleep patterns than morning preference. Furthermore, it was predicted that evening preference would also be associated with higher level of substance use at school term time. As no previous research has investigated associations between these variables and circadian preference during a holiday period, no specific hypotheses were forwarded for this time point, except for the expectation that evening preference would be associated with later bedtime and wake times, demonstrating a later circadian phase.

(c) Drawing on the morningness-eveningness literature, and findings suggesting that students with an evening tendency may find adaptation to the school schedule even more difficult than other students, the possible interaction between circadian preference and school schedule related changes in sleep measures was examined. It was predicted that evening type students would report decreased sleep duration, higher sleep debt, and more sleep irregularity than morning types at school time relative to holiday time.

4. **Predictors of Mood, Daytime Functioning and Grades**

Based on the findings of factors associated with daytime functioning, mood, and grades by Acebo and Carskadon (2002), Gianotti et al. (2002), Wolfson and Carskadon (1998), O’Brien and Mindell (2005), and Mercer et al. (1998) discussed in Chapters Four and Six, it was anticipated that at school time sleep variables and circadian preference would be significantly correlated and independently predict mood, daytime functioning, and grades. It was also expected that substance use and gender would significantly predict these outcome measures as well. These relationships were also explored for holiday time, and the relative importance of sleep quality and sleep duration as predictors of mood, daytime functioning and grades at school time were also investigated.
5. Modelling the Influence of Circadian Preference on Sleep Variables, Mood, Daytime Functioning and Grades

Correlational evidence that has been presented in Chapters Three, Four, and Five, showing that circadian preference, sleep quality, insufficient sleep, and irregular sleep have all been linked to several deleterious outcomes at school time. As noted in Chapter Four, causal pathways have been proposed by researchers suggesting that at school term time an evening preference negatively influences the quality and regularity of sleep, resulting in sleep deprivation and the subsequent consequences of poorer daytime function. It therefore seemed reasonable to explore a path analysis model comprising circadian preference, sleep variables, and outcome variables of mood, daytime functioning, and grades with the aim of examining the proposed relationships. It was then planned to ascertain whether this model was applicable to holiday time, and whether it could also be used to model the changes that may have occurred between holidays and school term.
Chapter Eight: Method

8:1 Overview

In this chapter the sample used in the current study is first described, along with information about the timing of the surveys and details of the measures used to elicit the data. Given the naturalistic repeated measures design of the study and the relatively large number of variables measured, existing tools for measuring sleep habits were too long for the current study. Two new scales were developed and included in the surveys for the present project, and are described in detail below along with the other measures utilised. Following this, the procedures used to conduct the study are outlined, along with an outline of the statistical methods used to analyse the data.

8:2 Participants

Three hundred and eighty Victorian senior secondary school students participated in a Time 1 (T1) (holiday) sleep habits survey. The students were undertaking years 11 (n = 318) or 12 (n = 62) at three different metropolitan secondary schools, and ages ranged from 15 to 18 years ($M = 16.04$, $SD = .63$). Two hundred and forty-two (63%) of the participants were female, 138 (36%) were male. Of 392 students invited to take part in the study, 9 students declined to participate, and three parents refused permission for their child to participate in the surveys. Start time at the schools was 8:30 a.m. and finish times ranged from 3:15 p.m. to 3:20 p.m.

At Time 2 (T2), during school term, 310 students (81% of the original 380) from the same three schools were present on the day of the survey. All these students participated in the second phase of the study. Fifty-six of the students were in year 12 and 254 were from year 11. One hundred and ninety-five of the participants (63%) were female and 115 (37%) were male, and ages ranged from 15 to 18 years ($M = 16.57$, $SD = .66$). At both time points the majority of students indicated that they were involved in a range of activities including sports, extra-curricular activities, part-time work, and socializing, and perceived their schedule as normal for them over the survey period. Additionally, at school term the majority of students indicated that they spent time at home completing schoolwork and studying.
8.3 Materials

A self-report survey adapted from the School Sleep Habits Survey (Wolfson & Carskadon, 1998) was designed for the current study in order to collect data about sleep habits, daytime functioning, mood, and grades during the summer holiday and the school term. A number of different measures were compiled for the 33-item survey, which was piloted in a focus group of ten students. Feedback indicated that some items required slight modifications due to culturally inappropriate or age inappropriate language in order to better suit the Australian adolescent sample. The survey was designed to elicit information about sleep habits, with slight variations in wording in order to accommodate reference to T1 (holidays) and T2 (school term). Appendix A contains the holiday and school time variants of the survey. The sleep log, scales, and qualitative items are detailed in the following sections. Age, year level, and gender variables were also collected, as well as self-reported ideal sleep time per night, and grades. Therefore T1 (holiday) grades provided a self-rated measure of academic achievement that had been obtained during the previous term at school, while T2 (school term) grades provided a current self-rated measure of achievement. This was primarily to maintain consistency in the surveys for the two time-points. The item asking about grades asked students to choose from eight possible response options the one that best described their academic achievement. An example of one of these is “mostly A’s and B’s”. This question was identical to the corresponding item about grades on the School Sleep Habits Survey. In some previous studies the response categories from this item have been used as categorical variables (Gianotti et al., 2002; O’Brien & Mindell, 2005; Wolfson & Carskadon, 1998). However, in the present study self-reported grades were coded from 1 (school marks “mostly D’s and E’s”) to 8 (“school marks mostly A’s”), resulting in an eight-point scale, as utilized by Acebo and Carskadon (2002) in previous work. Therefore, a higher score for this item denoted higher self-rated academic achievement.

8.3.1 The Sleep Log

The log was designed for the present study to elicit retrospective information about nocturnal sleep and wake times over a two-week period, and was modeled after questions 22, 24, 28, 29, 30 and 32 in the School Sleep Habits Survey (Wolfson & Carskadon, 1998). The School Sleep Habits Survey is contained in Appendix B, and is also available at www.sleepforscience.org.
The total hours of nocturnal sleep for T1 (holidays) and T2 (school term) was estimated by asking participants to reflect on the preceding two weeks and to indicate what time they usually went to bed for each day of the week, how long it took them to fall asleep, and what time they woke up the next day. These were open-ended questions, and participants were encouraged to give their best guess if they were not sure of the times. Where participants indicated a range of times, the midpoint was taken as the estimate. A number of sleep measures were calculated from the sleep log. For total sleep times the length of time that participants estimated that it took them to fall asleep was subtracted from total time between bedtime and wake-up time for each day. The seven days were summed to provide a total weekly sleep score. Weekday and weekend sleep times were similarly calculated by summing the appropriate night total sleep times. Weekend delay and oversleep were used as an indication of sleep irregularity, with longer bedtime delays and oversleeps on the weekend indicating a more irregular sleep pattern. Weekend delay was estimated as the difference between average weekday bedtime and average weekend bedtime. Weekend oversleep was ascertained by calculating the difference between average weekend and weekday wake-up times. Sleep debt was determined by subtracting reported weekday total sleep times from the ideal amount of sleep indicated by each student. Sleep time measures were analysed in minutes so that the variables were continuous, and then converted to hours and minutes for ease of interpretation in reporting. Bedtimes and wake-up times are reported in 24-hour clock time.

Previous research by Gehrman, Matt, Turingan, Dinh and Ancoli-Israel (2002) has found that retrospective estimates of usual sleep times over one month are highly reliable when compared to average daily recordings of sleep and wake times over one month. Strong correlations were found between estimates of bedtimes and wake-up times with average diary recordings ($r = 0.93$, and $r = 0.94$ respectively). Further support for the validity of retrospective sleep logs is provided by Gray and Watson (2002) who assert that sleep patterns are consistent from week to week. In a study comparing actigraph and subjective measures of sleep times, Lockley, Skene and Arendt (1999) reported good correlations between the two types of measures, with observations of $r = 0.77$ for sleep onset, and $r = 0.88$ for sleep offset times. Furthermore, evidence has been provided by Wolfson et al. (2003) that validates the use of self-report, retrospective surveys for researching adolescent sleep patterns. Surveys
of usual sleep/wake patterns were compared with daily sleep diaries and actigraphy with good agreement between the different data collection methods. School night survey reports of bedtimes tended to be a little earlier than those found through diary entries or actigraphy. On weekends the retrospective survey times tended to be a little later for bedtimes and longer for sleep times than those found with the diaries or actigraphs, however, significant correlations with these methods were observed, supporting the use of this methodology as a cost and time efficient way to collect data from adolescents in a school environment.

8.3.2 The Sleep Quality Scale

Although well-validated measures of sleep quality, such as the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989) are available, they have been designed for adults, tend to be long and complex, and as such, were deemed unsuited to the present adolescent sample. Consequently, a six-item Sleep Quality Scale (SQS) was developed to provide a measure of sleep quality for the current study. The scale was designed to represent sleep quality as a combination of subjective satisfaction with sleep duration, subjective ratings of overall quality, and frequency of difficulties initiating or maintaining sleep or early morning waking, as characterized in the literature (Buysse et al., 1989; Meijer et al., 2000; Pilcher et al., 1997). Items were chosen from other instruments on the basis of face validity to reflect each component of sleep quality as defined here for the current study. Five of these items were drawn from the 62-item School Sleep Habits Survey (Wolfson & Carskadon, 1998), with some minor changes to wording. A copy of this survey is contained in Appendix B. The sixth item, asking about early morning wakening, was adapted from an item on the 66-item Pittsburgh Insomnia Rating Scale (Moul, Pilkonis, Miewald, Carey, & Buysse, 2002) (see Appendix C). Full details about each of the items for the present SQS and how they were adapted and coded can be viewed in Appendix D. Together, these items assessed how often over the previous two weeks the participant experienced sleep difficulties such as waking during the night, early morning waking, and difficulty falling asleep, as well as how often the participant thought that they obtained enough sleep and their rating of their sleep quality. Five of the items had responses coded from 5 to 1, with one item with scores ranging from 1 to 3. Scores from the six items were summed to obtain a total score for global sleep quality. Possible scores on this scale ranged from 5.
to 26 with higher scores indicating better quality sleep. Psychometric properties of the SQS in the present sample were investigated prior to hypothesis testing.

8.3.3 The Daytime Functioning Scale
The Daytime Functioning Scale (DFS) was designed for the present study to assess a range of difficulties that have been identified as a consequence of insufficient or poor quality sleep in adolescents (Carskadon et al., 1983; Dahl, 1999; Fallone et al., 2001; Gianotti et al., 2002; Morrison et al., 1992; Wolfson & Carskadon, 1998). A series of 15 items asked whether the participant had experienced feelings of dissatisfaction during the day about their sleep, daytime sleepiness, or problem behaviours such as difficulties thinking clearly, feeling clumsy, irritable, or having difficulty controlling emotions over the previous two weeks. An example for sleepiness is “Over the past two weeks how often did you feel sleepy during the day?” The scale comprised 14 items (items B – O) that were adapted from Section B of the Pittsburgh Insomnia Rating Scale (Moul, Pilkonis, Miewald, Carey & Buysse, 2002) that assessed daytime dysfunction (see Appendix C). One further item (item A) was derived from Question 45 on the Sleep Habits Survey (Wolfson & Carskadon, 1998). Participants rated the frequency of these behaviours on a four-point scale (1 = never, 4 = everyday/night), with the first item being reverse scored. Possible scores ranged from 15 to 60, with higher scores indicating higher levels of daytime functioning. Appendix E contains the DFS, providing information on how each item was coded and adapted from other scales. Psychometric properties of the current scale were assessed prior to hypothesis testing.

8.3.4 The Short Mood and Feelings Questionnaire
Depression was measured on the Short Mood and Feelings Questionnaire (SMFQ) (Angold, Costello, Messer, Pickles, Winder, & Silver, 1995). This 13-item scale consists of statements such as “I did everything wrong”, which participants rate on a three point scale (true = 2, sometimes true = 1, not true = 0). As designed, the SMFQ provides for possible scores ranging from 0 to 26 with higher scores reflecting lower mood. However, for the present study, scoring was reversed so that higher scores reflected better mood. This was done to maintain consistency with the direction of other scales in the study and hence to facilitate interpretation of analyses. The scale was designed to quickly assess a core set of depressive symptoms in children and
adolescents aged 6 to 18 years over a two-week period, providing an effective screen for
depression using a minimum amount of items along with maximum criterion validity.

This scale has been found by Angold, Erkanli, Silberg, Eaves, and Costello
(2002) to correlate highly with other more extensive depression evaluations such as the
Children’s Depression Inventory (DISC-C) ($r = .67$) and the Diagnostic Interview
Schedule for Children ($r = .51$), and to successfully discriminate between depressed and
non-depressed subjects as diagnosed by the DISC-C, at a cut-off score of 8 or more
(Angold et al., 1995). Two-week test–retest correlations of .66 have been reported for
children (Costello & Angold, 1988), as well as .75 for a one week test-retest for
adolescents (Costello, Benjamin, Angold, & Silver, 1991). High internal scale
consistencies of .90 and .85 have also been reported for this scale (Angold et al., 1995;
Costello et al., 1991).

In response to comments from the focus group that the SMFQ scale on its own
had an overly negative quality, four positive self-esteem statements from Rosenberg’s
(1965) Self-Esteem Scale were added to the SMFQ. These were: “I felt I had a number
of good qualities”, “I was able to do things as well as most people”, “I took a positive
attitude toward myself”, and “I generally felt satisfied with myself”. The Self-Esteem
items were not scored, but were used to improve participants’ perceptions of the SMFQ.
Appendix F contains details of all the items presented.

8.3.5 The Superscience Morningness/Eveningness Scale

The Superscience Morningness/Eveningness Scale (SMES) (Carskadon, Viera &
Acebo, 1993) is a 10-item scale designed to evaluate circadian phase preference in
children and adolescents who attend school. The scale was adapted from the Composite
Morningness Scale of Smith, Reilly, and Midkiff (1989) which itself was derived from
two adult circadian rhythm scales, and devised to obtain superior psychometric
properties. Preference for morningness or eveningness is assessed by scoring responses
to questions about preferred timing for events such as getting up, sports practice, going
to bed, and taking tests.

One item (“Your parents have decided to let you set your own bed time. What
time would you pick?”) appeared inappropriate for the age group and was changed to:
“What time would you prefer to go to bed?” A further item was modified to reflect Australian language use, such that “gym class” was changed to “sports practice.” Three items have five possible responses and are coded from 5 to 1, with a further seven items having four possible responses each which are coded from 1 to 4. Item scores were summed with a possible score range of 10 (extreme evening preference) to 43 (extreme morning preference). The scale, along with details about coding and changes in wording, can be seen in Appendix G. The SMES can be used as a dimensional or categorical measure. For use as a categorical variable in the current study, scores on the SMES were divided into upper, lower, and middle terciles in order to maximize the number of participants in the relevant analyses. Participants in the lower tercile were classified as evening types and participants in the higher tercile were classified as morning types.

Excellent internal reliability was reported for Smith et al.’s (1989) Composite Morningness Scale (alpha = 0.87), and significant correlations with bedtimes and arisal times were reported in the expected direction. In their study of sixth grade children Carskadon et al. (1993) found that SMES scores were significantly correlated with self-reported bedtimes, and weekend wake-up times. Cronbach’s alphas of .73 and .82 have been reported by Gianotti et al. (2002) and Carskadon and Acebo (1992) respectively for this scale.

8.3.6 Perceived Reasons for Insufficient Sleep and Sleep Difficulties

As noted previously, one of the aims of the current study was to collect qualitative data regarding participants’ perceptions about their sleep habits. One item with four alternative responses assessed the participants’ main perceived reasons for not getting enough sleep (see Appendix H). The categorical responses offered were: “this did not apply – I got enough sleep”, “I had to get up earlier than I wanted”, “I stayed up too late”, and “I slept badly”. For the options of “I had to get up earlier than I wanted” and “I stayed up too late”, participants were asked to expand on their perceived reasons for this. They were prompted with “please state why e.g.: sport, family demands, job, etc.”

Three further items asked the participants to give their perceptions of the main reason for any sleep difficulties (see Appendix I). The categorical responses were as
follows: “did not apply”; physical reasons (“I wasn’t tired”, “I wasn’t well”); environmental reasons (“bothered by noise or light”, “too hot / cold/ uncomfortable”); cognitive reasons (“worried / concerned about personal problems”, “worried/ concerned about school”). These options were modeled on similar environmental and physical options provided in items 23 and 25 in the School Sleep Habits Survey (Wolfson & Carskadon, 1998). In the present study, cognitive options were included to reflect the work of Dahl and his colleagues (Dahl et al. 1996; Dahl & Lewin, 2002). Participants were also invited to write down any other perceived reasons for their sleep difficulties, and these were categorized into themes such as “active mind/thinking/reflecting”, “body clock”, “dreams/nightmares”, “mobile phone”.

8.3.7 Substance Use
Use of tobacco, caffeine, alcohol, and sleeping medication by participants was assessed in the present study with five items. These were rated on a four-point response scale (1 = never to 4 = every day) (see Appendix J). Four items asking about tobacco, caffeine, and alcohol use were taken from questions 44, a, b, c, and d on the School Sleep Habits Survey (Wolfson & Carskadon, 1998). The School Sleep Habits Survey also contains one item (44 e), asking about illicit drug use. This item was deemed inappropriate for the schools participating in the current study. One further item was added for the present study, asking about the use of sleeping medication either prescribed or “over the counter”. Scores could range from 4 to 20, with higher scores indicating high usage of a number of different substances. Previous studies have used this indication of different types of substance use as a scale with Cronbach’s alphas of .51 and .45 reported by Gianotti et al. (2002) and Carskadon et al. (1991), respectively. The reliability of the scale as presented in the current study was investigated before analyses were conducted.

8.3.8 Descriptive Items
One item asked students to estimate how many hours per week they spent in a paid job or family business, participating in sport or other extra-curricular activities, doing homework or study, and socializing. Two further items asked participants to indicate if the last two weeks had been fairly typical for them at this time of the year, and if not, to describe anything unusual that was happening for them over the last two weeks that may have affected their answers. Finally, participants were asked for any
other comments they would like to make about sleep and sleep difficulties. These items facilitated qualitative interpretation of the data.

8.4 Procedure

Permission to carry out the study was granted by the Swinburne University Human Research Ethics committee, and letters of permission were also obtained from the principals of the schools. Notices were sent home to parents detailing the study and requesting that they return a reply slip to the school if they did not wish their child to participate in the study. Three responses denying permission were returned to the schools and these students were excluded from participation.

Students were informed that their participation was voluntary, with consent forms completed by participants at both T1 (holidays) and T2 (school term). The T1 Holiday Sleep Habits survey was distributed to students to complete during class assemblies during the first week of February, 2003. This was the first week of the school term after six weeks of summer holidays. The T2 School Term Sleep Habits survey was distributed to the students during the final week of the third school term in mid September, 2003, at class assemblies. Students were instructed to answer each question and provide the answer that best described their situation or experience. The surveys were introduced to the students as research on sleep habits over the holidays and during school term time. A cover sheet explaining the purpose of the study accompanied the surveys.

Completed consent forms were collected separately from the surveys. Each participant was issued an identification number so that their data from T1 (holidays) could be collated with their data from T2 (school term). Sample copies of the letter to parents, cover sheets explaining the surveys, and the participant consent forms are included as Appendix K. At the end of each session surveys were collected by the teacher in charge and returned to the researcher.

8.5 Statistical Methods

Data was entered into the SPSS 12.01 statistical package, and the 0.05 level of significance was used in analyses, unless otherwise specified. Preliminary data screening was performed using frequency tables and box plots to check for out of range
data, outliers and missing values. Computation of scale scores was conducted along with scale reliabilities, assessment of normality, and assumptions for the intended analyses. Next, the validity of the SMES as a measure of trait morningness-eveningness, or circadian preference, was assessed by performing a paired samples t-test between T1 (holidays) and T2 (school term) measures of the scale. Bivariate correlations were also performed to ascertain whether any effects due to age were found in the present sample in regards to SMES scores, as well as a t-test to ascertain if there were any gender differences in SMES scores.

In order to address the hypothesis that sleep duration would be significantly shorter at T2 (school term) than at T1 (holidays) and also that students would wake significantly earlier, and would demonstrate greater sleep irregularity at T2 (school term) as compared to T1 (holidays), the data was analysed using Repeated Measures ANOVA. Repeated Measures ANOVA was also used to explore time-related changes in sleep quality, substance use, daytime functioning, mood and grades. A more conservative probability value of .01 was set to control for Type 1 error due to the large number of statistical tests performed in these analyses.

Frequencies were used to provide information about the prevalence of sleep difficulties at both time points, and to describe the students’ perceived reasons for sleep difficulties and insufficient sleep. Frequencies of categorised themes about additional perceived reasons that were provided in open-ended questions were also calculated.

Bivariate correlations were performed to test the hypotheses that evening preference would be significantly associated with a number of sleep related variables, as well as substance use, and bivariate correlations were also calculated to explore the relationship between circadian preference and these same variables at T1 (holidays). Bivariate correlations and standard multiple regression analyses were employed to assess the expectation that sleep variables, sleep quality, circadian preference, substance use and gender would predict mood, daytime functioning, and grades at school term. The relative importance of sleep quality in comparison to sleep quantity was also explored with bivariate correlations, as was the prediction of the outcome measures at T1 (holidays).
In order to assess the influence of circadian preference on sleep duration, sleep debt, and sleep pattern irregularity, mixed between-within ANOVAs were conducted. Sleep variables at T1 (holidays) and T2 (school term) were used as the within subjects variables with circadian type (T1 scores categorised into morning and evening types) as the between subjects variable.

Finally, a series of structural equation models (SEM) based on the hypothesised links between sleep variables, circadian preference, and outcome variables of mood, daytime functioning and grades was evaluated for “goodness of fit” with the data from the current study. SEM permits the analysis of several regression equations simultaneously, calculates the direct, indirect, and total effects of several interactive variables, and in addition, models interactions and allows testing of hypothesised directional relationships (Hair, Anderson, Tatham, & Black, 1998; Nachtigall, Kroehne, Funke, & Steyer 2003). Some researchers suggest that this allows causal inferences to be made about the relationships between a group of variables (Hair et al., 1998), while others argue that although SEM can illustrate causal relationships, a good fitting model does not necessarily test causality (Nachtigall et al., 2003).

Model testing was conducted using the Analysis of Moment Structures (AMOS) version 4.0 (Arbuckle & Wothke, 1995), which uses the maximum likelihood method to examine the overall fit of the model and requires multivariate normally distributed continuous variables. Kline (1998) has suggested that total sample size should be at least 200 subjects for SEM. Bentler (1995) contends that there should be between 5 and 10 cases for every parameter estimated in the model, and that the larger the parameter to case ratio the more trustworthy the results. Three indexes were used to assess the fit of the model to the data, as suggested by Byrne (2001). The chi-squared value divided by its degrees of freedom (CMIN/DF) was considered indicative of a good fit if this was found to be less than three (Carmines & McIver, 1981). A second index of fit utilized was the Root Mean Square of Approximation (RMSEA), which assesses how well the model approximates the true model. If the approximation is good, the RMSEA should be small, typically less than .08 (Browne and Cudeck, 1993). A third index of fit was the Comparative Fit Index (CFI), (Bentler, 1990). The CFI compares model fit with that of a null model (the independence model). CFI values equal to or greater than .90 are required to accept the model, indicating that 90% of the covariation in the data can
be reproduced by the given model. Additionally, an invariance test was performed to assess whether the same regression weights could be used for boys and girls for the T1 (holidays), T2 (school term), and change (T1 – T2) models.
Chapter Nine: Results

9.1 Overview

This chapter presents analyses of the data that was collected for the present study. Firstly preliminary data screening is discussed, followed by reliabilities of scales, and presentation of analyses that support the validity of the Superscience Morningness/Eveningness Scale (SMES) as a trait-like measure of circadian preference, followed by the investigation of possible gender differences in SMES scores. Descriptive statistics are then shown to provide an overview of the sleep patterns of the sample at both T1 (holidays) and T2 (school term), along with an examination of the differences found in these measures between holiday and school term. The prevalence of sleep difficulties in the sample is then addressed, including descriptions of the participants’ perceived reasons for these difficulties. Next, the results of analyses that show the relationships between circadian preference and sleep variables with the outcomes of mood, daytime functioning and grades are then presented, as well as regression analyses that identify significant predictors of each outcome measure at both time points from the sleep, circadian preference, substance use and gender variables. Following this, analyses of whether individual circadian preference moderates changes in sleep duration and irregularity of sleep patterns over time are described. Finally, the results of three structural equation models are presented which illustrate the complex direct and indirect relationships between circadian preference, sleep variables and the outcome measures of mood, daytime functioning and grades at both time points of the study.

9.2 Preliminary Data Analysis

9.2.1 Out of Range Values

Before computing scale scores the raw data was screened for out of range or implausible values using frequency tables and descriptive statistics. Three values were found to be out of range and were corrected.

9.2.2 Outlying Values

Preliminary investigation of sleep log data with box plots identified a small number of participants with unusual sleep patterns. Ten extreme outlying values were noted for sleep/wake times at T1 (holiday). Four of these outlying values were
accounted for by one participant who indicated that he had been fishing over the survey time. He noted irregular sleep and wake schedules, tending to sleep during the day and fish at night. Six further outlying values were accounted for by three participants who indicated that they didn’t sleep on one night during the week. Two of these participants reported that this was due to social activities, one participant did not comment on the reason for lack of sleep. Together, these outliers indicate the range of activities that adolescents were engaged in over the holidays and so all were included in analyses. However, average bedtime, wake-up times, weekend delay and oversleep times were not calculated for the three subjects who did not sleep on one night.

Twenty-one extreme outlying values were identified at T2 (school term) for sleep/wake times. Eleven outlying values arose from the responses of three participants who estimated that it took them 2 hours to fall asleep on one night. Eight further values were accounted for by responses indicating that social, sporting and part-time work activities were the reasons for their extreme bedtimes or wake-up times. Two other extreme values were accounted for by one participant who did not sleep on one night, indicating in the comments section of the survey that she had insomnia and could not sleep. Once again, these outlying values indicate the range of adolescent sleep/wake behaviours and were retained in analyses.

Average bedtime and wake-up times were not calculated for the participant who did not sleep. One extreme outlier was also found for ideal sleep time at T2 (school term). The ideal sleep time of 20 hours for this participant was changed to a less extreme value of 10 hours. This was in line with her response for T1 (holidays) when she indicated that 10 hours was ideal for her. No extreme outliers were found on the other measures and comparison of the 5% trimmed means with the means for each measure did not find that outlying values had a substantial influence on any of the mean values.

9.2.3 Recoding of Items and Missing Data

Two items were recoded on the Sleep Quality Scale (SQS) prior to totalling the scale score for this measure. Question 9 on the SQS (see Appendix D) was recoded so that the last option (“I have no idea”), which was originally scored as “1”, was recoded as missing data, in order to reflect that the participant was not able to estimate how
many times they woke at night. For T1 (holidays), twenty-five (6.6%) participants endorsed this option, and for T2 (school term), eleven (3.5%) of participants endorsed this option. Question 11 was recoded so that the first option (“too much sleep”) was coded as “0”, being the same value as “not enough sleep”. Both these options reflect a negative evaluation of amount of sleep. For T1 (holidays), forty-eight (12.6%) participants indicated that they got “too much sleep”, and at T2 (school term), eight (2.6%) participants endorsed this response.

Missing value analysis of all other survey items did not demonstrate a systematic pattern of missing data, except that missing data became more frequent near the end of the survey, possibly indicating participant fatigue. For example, 0.3% of the participants did not provide an answer to Question 5 in the T2 (school term) survey, while 1.5% of participants did not provide an answer to Question 30, towards the end of the T2 (school term) survey.

Of the 380 subjects at T1 (holidays), 11 subjects were removed from analyses due to having over 10% of missing data on their surveys. Of the 310 subjects at T2 (school term), three subjects were removed from further analysis due to having in excess of 10% of missing data on their surveys. For each scale, only subjects with less than 20% missing data were given a scale score. Subjects with more than 20% missing data were excluded from analyses using that measure. This applied to less than 2% of the sample. However, these values were imputed for the Structural Equation Models in the interest of retaining sample numbers.

9.2.4 Normality and Multicollinearity

Examination of skewness and kurtosis statistics for all variables suggested that the normality assumptions for analyses were not markedly violated. All of the variables in the current study demonstrated skewness or kurtosis values of less than 3.29, suggesting that they met the assumptions of normality for analyses (Tabachnick & Fidell, 2001). However, examination of normality plots suggested that the SMFQ scores were quite markedly negatively skewed. Angold et al. (2002) also noted that their distributions for the SMFQ were not approximately normally distributed in their two studies, as most children had very low depression scores. Consequently, a square root transformation was applied to the SMFQ scale scores, producing an approximately
normally distributed score for T1 and T2. This transformed variable was used in all analyses.

Multicollinearity of the predictor variables was assessed by checking Pearson’s correlation coefficients, showing that weekday, weekend and week sleep time variables at T1 (holidays) and T2 (school term) were not suitable to use together as independent variables in multiple regressions due to high intercorrelations. Similarly, ideal sleep and sleep debt at T2 (school term) were also highly intercorrelated, and therefore not suitable to be used together as predictors in the same analysis. Tabachnick and Fidell (2001) suggest that predictor variables that are correlated at .70 or above should not be used in the same analysis. Accordingly, only one of these measures was utilized in these analyses, depending on which one was most strongly correlated with the outcome variable of interest. Appendix L contains the correlation matrix of all the variables.

9.2.5 Scale Reliability

Using Cronbach’s alpha, internal reliability coefficients were calculated for all the scales and are presented in Table 1, along with the means and standard deviations.
Table 1

Means, Standard Deviations and Scale Reliability Alpha’s of Sleep Quality, Daytime Functioning, Short Moods and Feelings Questionnaire, and Superscience Morningness/Eveningness Scales for Time 1 and Time 2.

<table>
<thead>
<tr>
<th>Scale</th>
<th>M</th>
<th>SD</th>
<th>Possible Range</th>
<th>Cronbach’s Alpha</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1 (Holidays)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Quality Scale</td>
<td>18.01</td>
<td>2.90</td>
<td>5 - 26</td>
<td>.62</td>
<td>366</td>
</tr>
<tr>
<td>DFS</td>
<td>31.18</td>
<td>7.53</td>
<td>15 – 60</td>
<td>.88</td>
<td>368</td>
</tr>
<tr>
<td>SMFQ</td>
<td>21.00</td>
<td>4.61</td>
<td>0 – 26</td>
<td>.86</td>
<td>369</td>
</tr>
<tr>
<td>SMES</td>
<td>26.04</td>
<td>5.50</td>
<td>10 – 43</td>
<td>.83</td>
<td>365</td>
</tr>
<tr>
<td>Substance Use</td>
<td>9.11</td>
<td>2.57</td>
<td>5 – 20</td>
<td>.55</td>
<td>363</td>
</tr>
<tr>
<td><strong>Time 2 (School Term)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep Quality Scale</td>
<td>17.94</td>
<td>2.67</td>
<td>5 - 26</td>
<td>.64</td>
<td>307</td>
</tr>
<tr>
<td>DFS</td>
<td>28.28</td>
<td>8.12</td>
<td>15 – 60</td>
<td>.89</td>
<td>307</td>
</tr>
<tr>
<td>SMFQ</td>
<td>19.74</td>
<td>5.25</td>
<td>0 – 26</td>
<td>.89</td>
<td>307</td>
</tr>
<tr>
<td>SMES</td>
<td>25.88</td>
<td>5.25</td>
<td>10 – 43</td>
<td>.81</td>
<td>306</td>
</tr>
<tr>
<td>Substance Use</td>
<td>8.75</td>
<td>2.44</td>
<td>5 – 20</td>
<td>.56</td>
<td>306</td>
</tr>
</tbody>
</table>

Note: DFS = Daytime Functioning Scale; SMFQ = Short Moods and Feelings Questionnaire; SMES = Superscience Morningness/Eveningness Scale; +transformed values.

As shown, most scales demonstrated good internal reliability with Cronbach’s alphas of .80 or above, in line with findings in previous studies (Angold et al., 1995; Carskadon & Acebo, 1992; Costello et al., 1991). Scale distributions are also consistent with those found in previous studies for SMFQ and SMES (Acebo & Carskadon, 2002; Angold et al., 1995; Angold et al., 2002; Carskadon et al., 1993; Burrows & Cooper, 2002; Gianotti et al., 2002).

The exceptions to this were the Sleep Quality Scale and Substance Use. A similar low internal reliability was reported by Gianotti et al. (2002) and Carskadon et
al. (1991) for Substance Use in their studies. It is possible that the low internal reliability was the result of the small number of items in these scales. Inspection of the inter-item correlations for the measure indicated that the mean correlations for these were within the optimal range of .2 to .4, as recommended by Briggs and Cheek (1986). Accordingly, these scales were included in subsequent analyses.

9.2.6 Investigation of the Circadian Preference Measure, and Gender Differences in Circadian Preference Scores (Hypothesis 3a)

In order to assess the stability of SMES as a measure of trait circadian preference, bivariate correlations between SMES scores at holiday and school were conducted, and demonstrated temporal reliability ($r = .76, p < .001, n = 292$), while SMES at T1 (holidays) also correlated with sleep phase (measured as mid sleep for T1) ($r = -.48, p < .001$). A paired-samples t-test found no significant difference between SMES mean scores at T1 (holidays) ($M = 26.04, SD = 5.50; n = 292$) and T2 (school term) ($M = 25.90, SD = 5.29, n = 292$). On the basis of these analyses it was concluded that the SMES was measuring a trait-like circadian preference.

As age has a well-documented effect on morningness-eveningness scores in adolescents, bivariate correlations were conducted. Results showed that age was not significantly correlated with SMES scores at either time point, indicating that it was appropriate to assess the current sample (aged 15 – 18 years) as one group in regard to circadian preference. In order to test Hypothesis 3a that no gender differences would be found in SMES scores for this age group, t-tests were performed. Contrary to expectations a significant difference was revealed in scores for boys and girls at T1 ($t (363) = 3.46, p < .01$) and T2 ($t (304) = 3.03, p < .01$). Table 2 displays the mean scores on the SMES scale for boys and girls.
As seen in Table 2 the boys’ scores on the SMES tended slightly more towards eveningness in comparison to the girls, however the magnitude of differences in the mean scores was very small (T1 & T2 $\eta^2 = .01$). Scores on the SMES remained consistent over the two time points for both girls and boys.

9.3 Descriptive Statistics and Analysis of Time Related Changes

9.3.1 Time Related Differences in Sleep Variables (Hypothesis 1a)

A Repeated Measures ANOVA was performed on the data in order to investigate aim 1 and hypothesis 1 (a) that addressed significant differences between T1 (holidays) and T2 (school term) sleep variables. These variables were ideal sleep time, week, weekday and weekend sleep, weekday and weekend bedtimes and wake-up times, weekend oversleep, and weekend delay. A significance value of .01 for the analyses were set in order to control for Type 1 error. There was a significant, large effect for time (Wilks’ Lambda = .30, $F(8, 278) = 81.27$, $p< .001$, multivariate partial $\eta^2 = .70$). These results are displayed in Table 3, along with the means and standard deviations.
Table 3

*Means, Standard Deviations and F Values for Sleep Variables at T1 (Holidays) and T2 (School Term)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Holiday</th>
<th>School</th>
<th>F value</th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal Sleep Time hh:mm</td>
<td>08:46 1:09</td>
<td>08:43 1:21</td>
<td>.45</td>
<td>.00</td>
</tr>
<tr>
<td>Week Sleep hh:mm</td>
<td>09:06 1:20</td>
<td>08:11 0:51</td>
<td>137.71***</td>
<td>.32</td>
</tr>
<tr>
<td>Weekday Sleep hh:mm</td>
<td>09:12 1:26</td>
<td>07:55 0:52</td>
<td>199.22***</td>
<td>.41</td>
</tr>
<tr>
<td>Weekend Sleep hh:mm</td>
<td>08:53 1:31</td>
<td>08:51 1:41</td>
<td>.16</td>
<td>.00</td>
</tr>
<tr>
<td>Weekday Bedtime hh:mm</td>
<td>24:00 1:24</td>
<td>22:47 0:51</td>
<td>256.64***</td>
<td>.47</td>
</tr>
<tr>
<td>Weekend Bedtime hh:mm</td>
<td>00:46 1:31</td>
<td>00:24 1:16</td>
<td>22.30***</td>
<td>.07</td>
</tr>
<tr>
<td>Weekday Waketime hh:mm</td>
<td>09:38 1:50</td>
<td>07:04 0:29</td>
<td>594.33***</td>
<td>.68</td>
</tr>
<tr>
<td>Weekend Wake Time hh:mm</td>
<td>10:04 2:11</td>
<td>09:22 1:26</td>
<td>60.36***</td>
<td>.18</td>
</tr>
<tr>
<td>Weekend Oversleep hh:mm</td>
<td>-00:18 01:20</td>
<td>00:55 01:46</td>
<td>93.84***</td>
<td>.25</td>
</tr>
<tr>
<td>Weekend Delay hh:mm</td>
<td>00:46 00:58</td>
<td>01:37 01:08</td>
<td>122.18***</td>
<td>.30</td>
</tr>
<tr>
<td>Weekend Sleep Debt hh:mm</td>
<td>-00:25 01:30</td>
<td>00:48 01:13</td>
<td>180.03***</td>
<td>.39</td>
</tr>
</tbody>
</table>

*Note: n = 286; weekend oversleep = weekend – weekday wake-up times; weekend delay = weekend – weekday bedtimes; **p < .01, ***p < .001*

As highlighted in Table 3, there were significant time related differences between most of the sleep log measures. Exceptions were the ideal amount of sleep that students believed that they needed, and weekend sleep time - these sleep variables were consistent over the two time points.

During T1 (holidays) participants adopted later bedtimes and wake-up times, as opposed to T2 (school term). This difference was most marked in the weekday data. As predicted, participants slept significantly less per night during the school term as compared to the holidays, obtaining, on average, 55 minutes less sleep. On school nights (Sunday to Thursday nights), they slept significantly less (an average of 1:17 hours) than the same weeknights over the T1 (holiday) period, despite going to bed earlier than during the holidays.

Other significant differences were that the participants also tended to go to bed and get up a little earlier on T2 (school term) weekends than they did in the holidays.
Despite this, and as hypothesised, increases were noted in the irregularity of sleep schedules during school term, with longer delays between weekday and weekend bedtimes, and longer weekend oversleeps. Also as predicted, on school mornings (Monday to Friday), students reported waking up, on average, 2 hours, 34 minutes earlier during school term than they did during the holidays. On average, they obtained 1 hour, 22 minutes less sleep per night (sleep debt) than they believed was an ideal amount for them.

During the holidays the lowest reported average sleep time was 4 hours, 11 minutes, with the highest total sleep time of 13 hours, 31 minutes. At holiday time only 6% of the sample obtained less than 7 hours of sleep per night on average. During school term, average total sleep times ranged from a low of 3 hours, 51 minutes to a high of 10 hours, 55 minutes, with 15% of the sample reporting sleep times that were, on average, below 7 hours per night.

9.3.2 Time Related Differences in Sleep Quality, Substance Use, Daytime Functioning, Mood, and Grades (Hypothesis 1b)

A Repeated Measures ANOVA was performed on the data in order to ascertain whether scores for the Sleep Quality Scale (SQS), Substance Use, Daytime Functioning Scale (DFS), Short Mood and Feelings Questionnaire (SMFQ), and Grades differed significantly from T1 (holidays) to T2 (school term). Again, the .01 level of significance was set for these analyses. Table 4 displays the means and standard deviations. There was a significant effect for time (Wilks’ Lambda = .77, F(6, 281) = 16.21, p < .001, multivariate partial \( \eta^2 = .23 \)).
Table 4  
*Means, Standard Deviations and F Values for Substance Use, Sleep Quality Scale, Daytime Functioning Scale, Short Mood and Feelings Questionnaire and Superscience Morningness/Eveningness Scale Scores at Time 1 and Time 2.*

<table>
<thead>
<tr>
<th>Scale</th>
<th>T1 (Holidays)</th>
<th>T2 (School Term)</th>
<th>F value</th>
<th>Partial η²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Sleep Quality Scale</td>
<td>17.94</td>
<td>2.88</td>
<td>17.89</td>
<td>2.61</td>
</tr>
<tr>
<td>DFS</td>
<td>31.29</td>
<td>7.60</td>
<td>28.22</td>
<td>8.11</td>
</tr>
<tr>
<td>SMFQ</td>
<td>21.02</td>
<td>4.68</td>
<td>19.68</td>
<td>5.23</td>
</tr>
<tr>
<td>Grades</td>
<td>6.59</td>
<td>1.17</td>
<td>6.48</td>
<td>1.21</td>
</tr>
<tr>
<td>Substance use</td>
<td>9.09</td>
<td>2.57</td>
<td>8.72</td>
<td>2.43</td>
</tr>
</tbody>
</table>

*Note: n = 287; DFS = Daytime Functioning Scale; SMFQ = Short Mood and Feelings Questionnaire; **p < .01, ***p < .001; + transformed values*

As displayed above, the participants rated their sleep quality, as measured by the Sleep Quality Scale, similarly at both time points. However, the within subjects analysis of variance revealed significant differences between DFS scores, indicating that participants endorsed more impaired levels of functioning during school term. Scores on the SMFQ were significantly lower also during T2 (school term), indicating that participants rated their mood as significantly lower than at T1 (holiday time). The slight decrease in self-reported grades from the previous year did not reach the required significance level of .01. A significant drop in substance use was also found during T2 (school term).

Frequencies of responses to individual items on the DFS indicated that students endorsed that the following behaviours occurred more frequently for them at T2 (school term) than at T1 (holidays): difficulties waking up in the morning, increased feelings of sleepiness during the day, dozing off when they didn’t want to, difficulty focussing thoughts, remembering, and making decisions. In addition, students reported more frequently that others told them they looked tired, and they reported more bad moods.
because of lack of sleep, feelings of irritation with others, difficulties controlling emotions, and low energy and lethargy. Appendix M contains a summary of the frequencies of responses for the DFS at T1 and T2. Several cognitive and affective symptoms of depression on the SMFQ scale were endorsed more strongly at T2, including finding it hard to concentrate, feeling miserable or unhappy, believing oneself to be a bad person, and not being as good as others (see Appendix N).

For grades, participants most often reported that they obtained A’s and B’s at T1 (holidays), and T2 (school term). At T2 (school term) however, a slight increase was noted in the frequencies of self-reported C’s. Inspection of frequencies of responses to substance use items suggested that the drop in substance use from T1 (holidays) to T2 (school term) was due to decreased frequency of alcohol use during the school term. At T1 (holidays) participants had most often consumed alcohol several times over the past 2 weeks, followed by soft drinks containing caffeine, coffee or tea, tobacco, and sleeping medications in that order. At T2 (school term), a different pattern was reported. Soft drinks containing caffeine were endorsed as being consumed most often on several occasions over the time period, followed by coffee and tea, alcohol, tobacco, and sleeping medications respectively. Appendix O contains the summary of participant responses to the grades and substance use items for T1 and T2.

9.3.3 Subjective Sleep Quality and Prevalence of Sleep Difficulties (Research Question 2)

In order to explore the prevalence of sleep difficulties and perception of sleep quality, frequencies of responses to individual items on the Sleep Quality Scale were examined, with some of these results displayed in Table 5. Appendix P contains the summary data for these items.
As shown, the majority of students reported that they obtained insufficient sleep during the school term, about double the percentage of students complaining of this during holiday time. Interestingly, reported specific sleep difficulties of sleep onset latencies (fall asleep time) of over 30 minutes, night waking, and early morning waking, were less frequently reported during school term even though no significant differences were found between Sleep Quality scores over time (see Table 4). The percentage of students who endorsed that their overall sleep quality was poor remained consistent over time also, as shown in Table 5. Patterns of responses to items on the Sleep Quality Scale were different at holiday and term time, with dissatisfaction with sleep duration being more frequently indicated by students during school term, whereas difficulties getting off to sleep and staying asleep were specified more frequently during the holiday time. However, these data indicate that sleep difficulties were quite common experiences for the students in this sample, along with the perception of not obtaining enough sleep.
9.3.4 Perceived Reasons for Sleep Difficulties (Research Question 2)

In regard to experiencing difficulties falling asleep during holiday time, students were most likely to endorse the environmental reason of “feeling too hot, cold, or uncomfortable” as the main cause for this difficulty. This was followed by the physical explanation of “not feeling tired”, and the cognitive reason of “worrying about personal problems”. During the school term however, students responded most frequently to “worrying about personal problems”, “worrying about school” and “not feeling tired”. Students at both holiday and school time also indicated “other reasons” for difficulty falling asleep and were invited to write down their reasons. Of those who contributed to this, themes of “active mind/thinking/reflecting” were frequent at both T1 and T2, with “body clock/sleep patterns” also emerging frequently at holiday time. Some students indicated that mobile phone calls interrupted them getting off to sleep.

The most frequent responses for “waking during the night and having trouble getting back to sleep” in the holidays were “too hot/cold/uncomfortable”; “needing to use bathroom”; “bothered by noise or light”; and “worrying about personal problems”. During school term, responses were similar, with “feeling unwell” more frequent than “noise/ light”. At both times students also frequently endorsed “other reasons” for waking in the night. Themed reasons emerged of “active mind/thinking”; “waking for no apparent reason”; “dreams/nightmares” and “mobile phone ringing.”

For early morning waking, the frequency of responses was similar for holiday and school times with “not feeling tired”; “bothered by noise/light”; “feeling hot/cold/uncomfortable” being perceived as important reasons. During holiday times “other reasons” was also frequently endorsed and analysis of the themes revealed “body clock/ sleep patterns” and “active mind/thinking” to be important. During school term, both “worrying about personal problems” and “problems at school” were also frequently indicated (see Appendix Q for a summary of responses).

9.3.5 Perceived Reasons for Insufficient Sleep (Research Question 2)

Frequencies were examined to explore the reasons that students perceived to be the main cause of them not obtaining sufficient sleep at T1 (holiday) and T2 (school time). The most frequent response at both times was that they tended to stay up too late, followed by having to get up earlier than they wanted. At holiday time, the main reason students reported going to bed too late was due to socialising, followed by television
and computer use, with a small percentage stating that they stayed up reading, or at a paid job. The main reasons for having to get up earlier than they wanted during the holidays was due to job commitments, followed by sporting commitments, then family demands. During school term the main reason that students stayed up too late was again due to social reasons, followed by homework, computer and television use, part-time job, and reading. For school term, the main reason that students gave for not getting enough sleep due to having to get up too early was because of school, followed by before school sport and extra-curricular practice demands. Appendix R contains a summary of these responses. At both holiday and school times 12% of the sample indicated that the main reason that they obtained insufficient sleep due to “sleeping badly”. This is consistent with the percentage of the sample that rated their sleep quality as “poor” on the Sleep Quality Scale.

9.4 Circadian Preference and the Predictors of Sleep Variables, Sleep Quality, and Substance Use (Hypothesis 3b)

In order to test the hypothesis that evening preference would be related to a number of sleep variables and higher use of substances, bivariate correlations were performed on the data. A significance value of .01 was set for the analyses to control for Type I error. These results are displayed in Table 6.
Table 6

*Correlations Between SMES, Sleep Variables, Sleep Quality Scale, and Substance Use at T1 (Holiday) and T2 (School Term)*

<table>
<thead>
<tr>
<th>SMES Variables</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal Sleep</td>
<td>-.02</td>
<td>-.09</td>
</tr>
<tr>
<td><strong>Sleep Duration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week Sleep</td>
<td>-.14**</td>
<td>.09</td>
</tr>
<tr>
<td>Weekday Sleep</td>
<td>-.13*</td>
<td>.22***</td>
</tr>
<tr>
<td>Weekend Sleep</td>
<td>-.11*</td>
<td>-.11*</td>
</tr>
<tr>
<td><strong>Bed/Wake Times</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime Weekday</td>
<td>-.48***</td>
<td>-.43***</td>
</tr>
<tr>
<td>Bedtime Weekend</td>
<td>-.43***</td>
<td>-.28***</td>
</tr>
<tr>
<td>Wakeup Weekday</td>
<td>-.46***</td>
<td>-.38***</td>
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<tr>
<td>Wakeup Weekend</td>
<td>-.49***</td>
<td>-.42***</td>
</tr>
<tr>
<td><strong>Sleep Irregularity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekend Oversleep</td>
<td>.02</td>
<td>-.22***</td>
</tr>
<tr>
<td>Weekend Delay</td>
<td>-.02</td>
<td>.00</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday Sleep Debt</td>
<td>.12*</td>
<td>-.24***</td>
</tr>
<tr>
<td>Sleep Quality Scale</td>
<td>.01</td>
<td>.21***</td>
</tr>
<tr>
<td><strong>Behaviours</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substance Use</td>
<td>-.25***</td>
<td>-.13*</td>
</tr>
</tbody>
</table>

*Note:* SMES = Superscience Morningness/Eveningness Scale; 
* p < 0.05; ** p < 0.01; *** p < 0.001; (2-tailed);  n = 362 – 369 at T1;  n = 305 – 307 at T2

As presented in Table 6, and as anticipated, evening preference was significantly associated with later bedtimes and wake up times at T1 (holidays). Eveningness was significantly associated with longer week sleep times and higher substance use. No significant association was noted between circadian preference and sleep quality or sleep irregularity measures at this time.
At T2 (school term), however, and as predicted, morningness was significantly associated with longer school night sleep duration. A trend was detected indicating that eveningness was associated with longer sleep times on the weekend, but this did not reach the required significance level. Also as anticipated, eveningness was moderately correlated with later bedtimes and wake up times, longer weekend oversleeps, and more sleep debt. Contrary to expectations no significant association was found between eveningness and the need for more sleep as indicated in reported ideal sleep at either time point, nor was eveningness significantly related to weekend delay. Also contrary to expectations, the relationship between eveningness and substance use failed to meet the set criteria for significance.

9.5 Sleep Variables, Sleep Quality, Circadian Preference, Substance Use, and Gender as Predictors of Mood, Daytime Functioning and Grades (Hypothesis 4)

To examine the relationship between the sleep variables, Sleep Quality Scale (SQS), Superscience Morningness/Eveningness Scale (SMES), substance use, gender and the outcome variables (scores on the Short Mood and Feelings Questionnaire (SMFQ), Daytime Functioning scale (DFS) and grades), bivariate correlations were performed. Significance levels were set at .01. Table 7 presents the Pearson product-moment correlation coefficients.
Table 7  
**Correlations Between Sleep Variables, Sleep Quality Scale, Gender, SMES, Substance Use, SMFQ, DFS and Grades at T1 (Holiday) and T2 (School Term)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>SMFQ T1</th>
<th>SMFQ T2</th>
<th>DFS T1</th>
<th>DFS T2</th>
<th>Grades T1</th>
<th>Grades T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal Sleep</td>
<td>.01</td>
<td>.04</td>
<td>.04</td>
<td>-.14**</td>
<td>-.03</td>
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</tr>
<tr>
<td>Sleep Duration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week Sleep</td>
<td>.04</td>
<td>.17**</td>
<td>.05</td>
<td>.16**</td>
<td>-.15**</td>
<td>.01</td>
</tr>
<tr>
<td>Weekday Sleep</td>
<td>.02</td>
<td>.20**</td>
<td>.04</td>
<td>.17**</td>
<td>-.15**</td>
<td>.05</td>
</tr>
<tr>
<td>Weekend Sleep</td>
<td>.09</td>
<td>.05</td>
<td>.06</td>
<td>.07</td>
<td>-.10</td>
<td>-.04</td>
</tr>
<tr>
<td>Bed/Wake Times</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedtime Weekday</td>
<td>-.06</td>
<td>-.11*</td>
<td>-.19**</td>
<td>-.18**</td>
<td>-.08</td>
<td>-.13*</td>
</tr>
<tr>
<td>Bedtime Weekend</td>
<td>-.07</td>
<td>-.08</td>
<td>-.16**</td>
<td>-.18*</td>
<td>-.13*</td>
<td>-.21***</td>
</tr>
<tr>
<td>Wakeup Weekday</td>
<td>-.11*</td>
<td>.07</td>
<td>-.16**</td>
<td>-.07</td>
<td>-.18***</td>
<td>-.17**</td>
</tr>
<tr>
<td>Wakeup Weekend</td>
<td>-.04</td>
<td>.03</td>
<td>-.12*</td>
<td>-.10</td>
<td>-.19***</td>
<td>-.22***</td>
</tr>
<tr>
<td>Sleep Irregularity</td>
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<td></td>
</tr>
<tr>
<td>Weekend Oversleep</td>
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<td>-.05</td>
<td>.03</td>
<td>-.02</td>
<td>.04</td>
<td>-.06</td>
</tr>
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<td>.02</td>
<td>.00</td>
<td>.01</td>
<td>-.07</td>
<td>-.10</td>
<td>-.15**</td>
</tr>
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<td></td>
</tr>
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<td>Weekday Sleep Debt</td>
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<td>.01</td>
<td>-.25***</td>
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<td>.04</td>
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<td>.22***</td>
<td>.21**</td>
<td>.12*</td>
<td>.17**</td>
<td>-.28**</td>
<td>-.29***</td>
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<td>SMES</td>
<td>.14**</td>
<td>.16**</td>
<td>.20***</td>
<td>.27**</td>
<td>.18**</td>
<td>.21***</td>
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<td>Behaviours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Substance Use</td>
<td>-.24***</td>
<td>-.14*</td>
<td>-.31***</td>
<td>-.23***</td>
<td>-.22***</td>
<td>-.22***</td>
</tr>
</tbody>
</table>

Note: SMES = Superscience Morningness/Eveningness Scale; * p < 0.05; ** p < 0.01; *** p < 0.001 (2-tailed); n = 362 – 369 at T1; n = 305 – 307 at T2.

As seen in Table 7, ideal sleep was unrelated to any of the outcome variables except for a significant negative correlation at T2 (school term), indicating that students who thought they required more sleep tended to experience more impaired daytime functioning during the school term. For T1 (holidays) sleep duration times were unrelated to SMFQ or DFS scores, however, weak, negative associations were found between week and weekday sleep duration and grades, indicating that students who
reported lower grades the previous term tended to sleep for longer than other students during the holidays. Significant correlations between wake up times, gender, SMES, substance use and grades were also revealed, indicating that students who reported later holiday wake times, eveningness, and higher substance use were more likely to have reported lower grades. They were also more likely to be boys than girls. However, lower SMFQ and DFS scores were significantly associated with poorer sleep quality, eveningness, higher substance use and those who reported lower mood were more likely to be girls than boys.

As predicted for T2 (school term), sleep variables, circadian preference, substance use and gender were significantly associated with the outcome measures. Lower scores on the DFS were significantly associated with shorter school night sleep duration, later bedtimes, higher sleep debt, poorer sleep quality, evening preference, higher substance use, and female gender. Lower scores on the SMFQ were significantly associated with shorter school night sleep duration, poorer sleep quality, evening preference, higher substance use, and female gender. Significant associations were found between lower grades at T2 (school term) and later bed times and wake times, an evening preference, male gender, higher substance use, and weekend delay. Notably, sleep irregularity was not significantly associated with scores on the DFS or SMFQ, and sleep duration was not associated with lower grades.

In summary, these results suggest that students with more of a morning preference enjoyed better mood, daytime functioning, as well as reporting better grades, than evening oriented students at both holiday and school term. Interestingly, students who reported lower grades tended to sleep more over the holidays compared to higher achieving students, while at term time, lower achieving students tended to stay up later and go to bed later than others. Poor sleep quality, an evening preference, female gender, and higher substance use were all consistently associated with poorer mood and functioning at holiday and school time, with the exception of substance use and mood at school time. Lower sleep duration was also associated with these poorer outcomes at T2 (school time).
9.6 Predicting Mood, Function and Grades (Hypothesis 4)

A series of standard regression analyses were conducted to test the hypotheses that sleep variables, circadian preference, substance use and gender would independently predict the outcome measures of mood, daytime functioning, and grades at T2 (school term). These analyses were also used to assess whether sleep quality contributed uniquely to these outcomes, and to explore the relative importance of sleep quality and sleep duration as independent predictors of the outcomes. The relationships between the variables at T1 (holidays) were assessed in three further regressions. The multiple analyses used gender, SMES scores, weekday sleep duration, weekday sleep debt, and the sleep pattern irregularity variables of weekend oversleep, and weekend delay as predictors. Substance use was also used as a predictor variable, as in previous work (Gianotti et al., 2002). The SMFQ, DFS and grades were used as dependent measures in the multiple regressions. For these regression analyses only variables that were significantly correlated with each outcome measure were included as predictors (see Table 8). Where multicollinearity was an issue (see section 9.2.3), the variable most strongly correlated with the dependent variable of interest was utilised for analysis. The results of these analyses, showing the significant standardised beta weights, are presented in Table 8.
Table 8

Regressions: Predicting SMFQ, DFS, and Grades from Sleep Variables, SMES, Gender, and Substance Use for T1 (Holidays) and T2 (School Term) (Beta Weights)

<table>
<thead>
<tr>
<th>Measure</th>
<th>T1 (Holidays)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SMFQ</td>
<td>DFS</td>
<td>Grades</td>
<td>SMFQ</td>
<td>DFS</td>
<td>Grades</td>
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<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Weekday Sleep</td>
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<td>-</td>
<td>-.17*</td>
<td>.10*</td>
<td>.02</td>
<td>-</td>
</tr>
<tr>
<td>Weekend Oversleep</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Weekend Delay</td>
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<td>-</td>
<td>-</td>
<td>-.11*</td>
<td>-</td>
<td>-.11*</td>
</tr>
<tr>
<td>Weekday Sleep Debt</td>
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<td>-</td>
<td>-.04</td>
<td>-</td>
<td>-.15**</td>
<td>-</td>
</tr>
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<td>Sleep Quality Scale</td>
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<td>-</td>
<td>.36***</td>
<td>.41***</td>
<td>-</td>
</tr>
<tr>
<td>Gender</td>
<td>.12**</td>
<td>.06</td>
<td>-.29***</td>
<td>.15**</td>
<td>.13*</td>
<td>-.27***</td>
</tr>
<tr>
<td>SM/ES</td>
<td>.13**</td>
<td>.15**</td>
<td>.05</td>
<td>.08</td>
<td>.15**</td>
<td>.14*</td>
</tr>
<tr>
<td>Substance Use</td>
<td>-.14**</td>
<td>-.22***</td>
<td>-.22***</td>
<td>-.11*</td>
<td>-.20***</td>
<td>-.16**</td>
</tr>
<tr>
<td>R -square</td>
<td>.27</td>
<td>.32</td>
<td>.16</td>
<td>.23</td>
<td>.33</td>
<td>.16</td>
</tr>
<tr>
<td>F-value</td>
<td>32.60***</td>
<td>42.60***</td>
<td>13.48***</td>
<td>18.28***</td>
<td>25.79***</td>
<td>14.21***</td>
</tr>
<tr>
<td>df</td>
<td>4, 357</td>
<td>4, 357</td>
<td>5, 358</td>
<td>5, 300</td>
<td>6, 299</td>
<td>4, 299</td>
</tr>
</tbody>
</table>

Note: SMFQ = Short Mood and Feelings Questionnaire; DFS = Daytime Functioning Scale; SMES = Superscience Morningness/Eveningness Scale; *p < .05; **p < .01; ***p < .001.

As shown in Table 8, the expectation that outcome measures of SMFQ, DFS, and Grades at T2 (school term) were predictable from scores on sleep measures, SMES, gender, and substance use was generally supported. The six regression equations were found to be significant, and moderate amounts of variance were accounted for by the predictor variables at both times. Between 23 to 33% of the variance in SMFQ and DFS, and 16% of the variance in the scores for grades were explained by the regression equations for T1 (holidays) and T2 (school term).

SMFQ scores were independently predicted at T2 (school term) by sleep quality, sleep duration, substance use, and gender suggesting that students with lower mood tended to be female, report poorer sleep quality, shorter school night sleep duration, and higher use of substances. However, contrary to expectations, evening preference was not found to independently predict this poorer outcome, despite significant associations found with bivariate correlations at both time points (see Table 8). This suggests a more complex relationship may exist between circadian preference and mood.
For SMFQ scores at T1 (holidays) similar results were found, with the exception that weekday sleep duration was not a predictor of mood at this time point, but circadian preference was a significant predictor. The most important predictor in the models at both times was sleep quality, with lower quality sleep predicting lower mood. Substance use was the next most important predictor at both times.

In regards to poor daytime functioning, as measured by the DFS, at T2 (school term) this variable was independently predicted by higher sleep debt, poorer sleep quality, evening preference, female gender and higher substance use. At T1 (holidays) lower DFS scores were predicted by poorer sleep quality, an evening preference, and higher substance use. Again, the most important predictor in the regressions for both times was Sleep Quality Scale scores, followed by substance use, and then SMES scores.

Turning to the outcome of Grades, the results of the regressions for T2 (school term) were as expected. Male gender, higher substance use, longer weekend delay, and evening preference were found to independently predict lower grades. At T1 (holidays) male gender, higher substance use and longer weekday sleep duration were found to be the significant independent predictors of lower grades. At both time points, male gender was the most important predictor of self-reported lower grades, followed by higher use of substances.

Taken together, the regression equations indicated that sleep duration and irregularity of sleep patterns were less important predictors of mood and daytime functioning than sleep quality. Sleep quality was the most important predictor for these two outcome variables at both T1 (holidays) and T2 (school term), with sleep duration found to independently predict only mood, as measured by the SMFQ, at T2 (school term). The irregular sleep pattern measure of longer weekend delay independently predicted lower grades at T2 (school term), while longer sleep duration independently predicted lower self-reported school achievement at T1 (holidays).

Scores on the SMES were found to independently predict daytime functioning, as measured by DFS scores, at T1 (holidays) and T2 (school term), as well as SMFQ at T1 and grades at T2, indicating that participants with a morning preference tended to enjoy
higher levels of daytime functioning both at holiday and school term in comparison to those with an evening preference, and also reported higher mood over the holidays and higher school grades in the T2 (school term) survey.

9.7 The Influence of Trait Circadian Preference on Sleep Duration and Sleep Pattern Irregularity (Hypothesis 3c)

As established previously, and displayed in Table 3, significant time related differences were found between sleep variables of interest for T1 (holiday) and T2 (school term), indicating that the imposition of the school term schedule resulted in students tending to obtain less sleep, report greater sleep debts, and more irregular sleep patterns with longer weekend bedtime delays and oversleeps.

To explore whether circadian preference, as measured on the Superscience Morningness-Eveningness Scale (SMES), influenced sleep variables over and above the impact of school schedule, mixed between-within ANOVAs were conducted. The dependent variables consisted of weekday sleep duration, sleep debt, weekend oversleep and weekend delay, with a within-subjects factor of time (T1 and T2). The between-subjects variable was circadian type. Scores on the SMES at T1 (holidays) were utilized for this as it was decided that this gave a base measure of circadian preference during largely self-selected sleep/wake cycles during the holiday period. T1 scores on the SMES were divided into thirds with the upper turcile being classified as morning type and the lower turcile as evening type. Subjects who fell into the middle band and classified as neutral were excluded from these analyses.

The mixed between-within ANOVAs revealed that there was a significant interaction between circadian type and time for weekday sleep duration (Wilks’ Lambda = .93, F(1,194) = 12.90 p < .001, multivariate partial $\eta^2 = .06$), and sleep debt (Wilks’ Lambda = .94, F(1,194) = 11.65, p < .01, multivariate partial $\eta^2 = .06$). No significant interactions were found between circadian type and time for weekend oversleep, or weekend delay, and no main effect for circadian preference was found in any of the analyses. Together, these results indicated that a significant proportion of the variance in weekday sleep duration and sleep debt was therefore explained by an interaction between circadian preference and the change in schedule from T1 (holiday) to T2 (school term). Figures 1 - 4 display the estimated marginal means in minutes for
weekday sleep duration, sleep debt, weekend delay and oversleep for morning and evening circadian types at T1 (holidays) and T2 (school term), and also illustrate the interaction effect for weekday sleep and sleep debt. Table 9 provides this information in hours and minutes, along with standard deviations for the measures. Evening type students obtained less weekday sleep and accrued larger sleep debts than morning types at school time relative to holiday time, demonstrating that individual differences in circadian preference impacted on sleep duration and sleep debt over and above the imposition of school schedule.

Finally, as gender and SMES scores were found to be linked, with males demonstrating more of an evening preference than females, the mixed between-within ANOVA analyses were conducted again, this time adding gender to the model. The time x circadian preference interaction was unaffected in each case.
Figure 1. Weekday sleep for circadian types at T1 (holidays) and T2 (school term).

Figure 2. Sleep debt for circadian types at T1 (holidays) and T2 (school term).
Figure 3. Weekend oversleep for circadian types at T1 (holidays) and T2 (school term).

Figure 4. Weekend delay for circadian types at T1 (holidays) and T2 (school term).
Table 9
*Means and Standard Deviations for Sleep Variables According to Circadian Preference for T1 (holidays) and T2 (school term)*

<table>
<thead>
<tr>
<th>Sleep Variable</th>
<th>Evening Types</th>
<th>Morning Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>S</td>
</tr>
<tr>
<td>T1 Weekday Sleep hh:mm</td>
<td>9:20</td>
<td>1:26</td>
</tr>
<tr>
<td>T2 Weekday Sleep hh:mm</td>
<td>7:39</td>
<td>0:53</td>
</tr>
<tr>
<td>T1 Sleep Debt hh:mm</td>
<td>-0:25</td>
<td>1:33</td>
</tr>
<tr>
<td>T2 Sleep Debt hh:mm</td>
<td>1:11</td>
<td>1:15</td>
</tr>
<tr>
<td>T1 Oversleep hh:mm</td>
<td>-0:20</td>
<td>1:25</td>
</tr>
<tr>
<td>T2 Oversleep hh:mm</td>
<td>1:05</td>
<td>2:05</td>
</tr>
<tr>
<td>T1 Delay hh:mm</td>
<td>0:44</td>
<td>1:04</td>
</tr>
<tr>
<td>T2 Delay hh:mm</td>
<td>1:43</td>
<td>1:11</td>
</tr>
</tbody>
</table>

*Note:* total n = 196; evening type (< = 21) n = 112; morning type (>= 32) n = 84.

9.8 Modelling the Influence of Circadian Preference on Sleep Variables and Outcome Variables at T1 (holidays), T2 (school term), and for Change Data (T1 – T2) (Hypothesis/Research Question 5)

The hypothesis that at T2 (school term) circadian preference would indirectly impact on outcome measures of mood, daytime functioning, and grades, through its direct effect on sleep variables was tested using Structural Equation Modelling (SEM). This methodology was also used to assess whether the model of the hypothesised relationships at T2 (school term) could also satisfactorily depict the T1 (holiday) data. Furthermore, SEM was utilised to model the hypothesised influence of circadian preference on changes to mood and daytime functioning via its influence on changes to sleep variables with the imposition of school schedule. A theoretical model was firstly designed for T2 (school term) using circadian preference, (assessed by continuous measurement on the SMES), weekday sleep duration, sleep debt, sleep quality, the irregular sleep pattern measures of weekend delay and oversleep, and the outcome measures of mood (measured by the SMFQ), daytime functioning (measured by the DFS) and grades. The proposed model, based on previous findings and suggestions in the literature, is displayed below in Figure 5.
Figure 5. Model 0: Proposed Diagram of Theorised Links Between Circadian Preference, Sleep Variables, Mood, Daytime Functioning and Grades at T2 (school term).

The direct and indirect links in Model 0 were proposed in line with findings from previous studies and hypotheses that have been forwarded in the literature. Direct links from circadian preference to all the sleep variables, sleep quality, mood, daytime
functioning, and grades were anticipated. It was proposed that a bi-directional relationship would be found between sleep quality and sleep duration variables, and that sleep quality would directly influence mood and daytime functioning. Direct paths from daytime functioning to grades, and from mood to function are also represented in the model. Previous findings have also indicated that lower sleep duration and greater sleep debt are directly related to poorer mood and daytime functioning, while sleep irregularity, measured as greater weekend delay and/or oversleep, has been directly linked with poorer grades, as well as hypothesized to contribute to impaired daytime functioning. The literature has also suggested that mood and sleep quality are bi-directional. Accordingly these bi-directional links are also represented in Figure 5. Each link is labelled at the midpoint of the line (e.g., W1) so that the weights for each link may be identified clearly in the accompanying tables. Error terms are labelled on the model (e.g., e1). Additionally, as sleep debt and weekday sleep, as well as weekend delay and oversleep are intercorrelated, and these relationships are represented by correlated error terms, (e.g., C1). For example, the error in weekday sleep estimations also contributes to the error in sleep debt measurement. The coefficients for these correlated error terms may be identified in the relevant tables.

As SEM is sensitive to sample size, and pairwise deletion for missing data is not recommended due to the potential to bias chi-square statistics, missing values were imputed using the Expectation Maximization Algorithm in SPSS before using the data in structural equation modelling in order to retain the maximum number of participants. It is generally accepted that for every parameter estimated in the model, there should be between 5 and 10 cases, and the larger the parameter to case ratio the more reliable the results (Bentler, 1995). For Model 0 the case ratio was 1:6 for the total sample, whereas for the final T2 (school term) model it was 1:9, and 1:11 for the change data model.

The acceptance criteria for the models were: a value of less than three for the chi-squared value divided by its degrees of freedom (CMIN/DF); a value of less than .08 for the Root Mean Square of Approximation (RMSEA); and a value equal to or greater than .90 for the Comparative Fit Index (CFI) (see section 8.5 for more detailed discussion of indices of fit). The model (Model 0), as displayed in Figure 5, was fitted to the T2 (school term) data, and found to be an acceptable fit (CMIN/DF = 1.75,
RMSEA = .05, CFI = .91). However, several non-significant links were revealed and are detailed below in Table 10.

Table 10

Non-significant Links in Proposed Model for T2 (school term).

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Link</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMFQ</td>
<td>Sleep Quality</td>
<td>W31</td>
<td>0.92</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>Sleep Debt</td>
<td>W5</td>
<td>0.35</td>
</tr>
<tr>
<td>SMES</td>
<td>Oversleep</td>
<td>W20</td>
<td>0.72</td>
</tr>
<tr>
<td>Delay</td>
<td>DFS</td>
<td>W16</td>
<td>0.44</td>
</tr>
<tr>
<td>SMES</td>
<td>Delay</td>
<td>W3</td>
<td>0.10</td>
</tr>
<tr>
<td>Delay</td>
<td>Grades</td>
<td>W15</td>
<td>0.09</td>
</tr>
<tr>
<td>Grades</td>
<td>SMES</td>
<td>W13</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Note: n = 307; SMFQ = Short Moods and Feelings Questionnaire; SMES = Superscience Morningness/Eveningness Scale; DFS = Daytime Functioning Scale.

As seen in Table 10, and contrary to predictions, weekend delay and oversleep did not contribute to the proposed model at all, so these variables were removed. Bidirectional pathways from mood to sleep quality and from sleep quality to sleep duration variables were insignificant and these were also removed along with the other identified non-significant pathways. After these modifications were made the model was resubmitted. The resulting model (Model 1), was found to be a good fit with the data (CMIN/DF = 1.448, RMSEA = 0.038, CFI = 0.961), and is displayed in Figure 6. The same measurement model was then fitted to both boys’ and girls’ data separately, and an F-test was used to determine whether the same coefficients could be used for both groups, as previous analyses established that boys tended slightly more towards eveningness than the girls. Although the goodness of fit statistics improved slightly when weights and covariances were permitted to vary across groups (CMIN/DF = 1.429, RMSEA = 0.037, CFI = .979), the improvement was not significant and it was found that the same model was applicable to both groups, (F(13,16) = 1.03, p > .05).
The significance values for the unstandardised coefficients (weights) for Model 1 are shown in Table 11, along with the standardised coefficients (weights) for boys and girls.

Figure 6. Model 1: Final Model for T2 (school term).
Table 11

*Estimated Standardised Coefficients and Significance Values for T2 (school term).*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Link</th>
<th>P-Value for Unstandardised Coefficients</th>
<th>Standardised Coefficients Boys</th>
<th>Standardised Coefficients Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMES</td>
<td>Sleep Debt</td>
<td>W2</td>
<td>0.000</td>
<td>-0.22</td>
<td>-0.26</td>
</tr>
<tr>
<td>Sleep Debt</td>
<td>Sleep Quality</td>
<td>W1</td>
<td>0.016</td>
<td>-0.15</td>
<td>-0.13</td>
</tr>
<tr>
<td>SMES</td>
<td>Weekday Sleep</td>
<td>W4</td>
<td>0.000</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>SMES</td>
<td>Sleep Quality</td>
<td>W8</td>
<td>0.000</td>
<td>0.21</td>
<td>0.22</td>
</tr>
<tr>
<td>Weekday Sleep</td>
<td>SMFQ</td>
<td>W6</td>
<td>0.030</td>
<td>0.14</td>
<td>0.10</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>SMFQ</td>
<td>W9</td>
<td>0.000</td>
<td>0.42</td>
<td>0.29</td>
</tr>
<tr>
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<td>SMFQ</td>
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<td>0.15</td>
<td>0.11</td>
</tr>
<tr>
<td>SMFQ</td>
<td>DFS</td>
<td>W3</td>
<td>0.000</td>
<td>0.28</td>
<td>0.41</td>
</tr>
<tr>
<td>Sleep Debt</td>
<td>DFS</td>
<td>W5</td>
<td>0.004</td>
<td>-0.14</td>
<td>-0.12</td>
</tr>
<tr>
<td>SMES</td>
<td>DFS</td>
<td>W7</td>
<td>0.009</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>DFS</td>
<td>W13</td>
<td>0.000</td>
<td>0.29</td>
<td>0.29</td>
</tr>
<tr>
<td>DFS</td>
<td>Grades</td>
<td>W14</td>
<td>0.000</td>
<td>0.16</td>
<td>0.21</td>
</tr>
<tr>
<td>e6</td>
<td>e3</td>
<td>C1</td>
<td>0.000</td>
<td>-0.35</td>
<td>-0.38</td>
</tr>
</tbody>
</table>

*Note:* n = 307; Female n = 191; Male n = 116; SMES = Superscience Morningness/Eveningness Scale; DFS = Daytime Functioning Scale; SMFQ = Short Mood and Feelings Questionnaire.

As seen in Table 11, the standardised coefficients were similar for girls and boys for most of the direct effects, with differences reflecting differences in means and standard deviations on the respective measures (e.g., from sleep quality to SMFQ). The model illustrated in Figure 6 demonstrates that some of the proposed links in the initial model were mediated by other variables, indicating indirect rather than direct relationships. As anticipated, direct relationships were observed between circadian preference and the sleep variables of weekday sleep and sleep debt, sleep quality, mood, and daytime functioning. However, an indirect relationship occurred in the case of grades, with this relationship being mediated by the other variables in the model. As demonstrated in Figure 6, not only does circadian preference have a weak, direct
relationship with the outcome variables of mood and daytime functioning, but, as hypothesised, there are also indirect relationships through its influence on weekday sleep, sleep debt, and sleep quality, with these variables in turn directly influencing mood, daytime functioning, and grades. Notably, weekday sleep contributed directly to mood, whereas sleep debt contributed directly to daytime functioning scores. However, these relationships were weak.

Model 1 was then submitted again, this time using the T1 (holiday) data. The goodness of fit indices indicated that the model was an acceptable representation of the sample data (CMIN/DF = 2.19, RMSEA = 0.06, CFI = 0.93). It was then fitted to girls and boys data separately, and was found to fit marginally better with the data (CMIN/DF = 2.02, RMSEA = 0.05, CFI = 0.97), but again the difference was not significant, suggesting no advantage in allowing different weights and covariances for the two groups ($F(18,16) = 1.19, p > .05$). Table 12 displays the significance values for the unstandardised coefficients along with the standardised coefficients for this model.
### Table 12

*Estimated Standardised Coefficients and Significance Values for T1 (holidays).*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Link</th>
<th>P-Value for Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMES</td>
<td>Sleep Debt</td>
<td>W2</td>
<td>0.752</td>
<td>-0.03</td>
</tr>
<tr>
<td>Sleep Debt</td>
<td>Sleep Quality</td>
<td>W1</td>
<td>0.758</td>
<td>0.03</td>
</tr>
<tr>
<td>SMES</td>
<td>Weekday Sleep</td>
<td>W4</td>
<td>0.362</td>
<td>-0.08</td>
</tr>
<tr>
<td>SMES</td>
<td>Sleep Quality</td>
<td>W8</td>
<td>0.392</td>
<td>0.08</td>
</tr>
<tr>
<td>Weekday Sleep</td>
<td>SMFQ</td>
<td>W6</td>
<td>0.987</td>
<td>0.00</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>SMFQ</td>
<td>W9</td>
<td>0.000</td>
<td>0.29</td>
</tr>
<tr>
<td>SMES</td>
<td>SMFQ</td>
<td>W16</td>
<td>0.000</td>
<td>0.33</td>
</tr>
<tr>
<td>SMFQ</td>
<td>DFS</td>
<td>W3</td>
<td>0.000</td>
<td>0.35</td>
</tr>
<tr>
<td>Sleep Debt</td>
<td>DFS</td>
<td>W5</td>
<td>0.248</td>
<td>0.07</td>
</tr>
<tr>
<td>SMES</td>
<td>DFS</td>
<td>W7</td>
<td>0.000</td>
<td>0.28</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>DFS</td>
<td>W13</td>
<td>0.000</td>
<td>0.35</td>
</tr>
<tr>
<td>DFS</td>
<td>Grades</td>
<td>W14</td>
<td>0.000</td>
<td>0.29</td>
</tr>
<tr>
<td>e6</td>
<td>e3</td>
<td>C1</td>
<td>0.000</td>
<td>-0.69</td>
</tr>
</tbody>
</table>

*Note: n = 369; Female n = 240; Male n = 129; SMES = Superscience Morningness/Eveningness Scale; SMFQ = Short Mood and Feelings Questionnaire; DFS = Daytime Functioning Scale.*

As seen in Table 12, the significance levels indicated that circadian preference, as measured by the SMES, was not directly related to any of the sleep variables (weekday sleep, sleep debt, sleep quality) during the holidays. Several other links that were supported for the T2 (school term) data were not found to be applicable to the T1 (holidays) data. No direct links were observed between sleep debt and sleep quality, weekday sleep and SMFQ scores, or sleep debt and DFS scores. This indicated that the theorised links between circadian preference, sleep, and outcome measures may not be present when students have more of an opportunity to self-select sleep patterns, as they do in the holidays.
Given that the absence of these links are theoretically meaningful when viewed in relation to more ideal sleeping opportunities, these links were removed from the model. It was decided to retain grades in the holiday model, even though this measure referred to academic achievement in the previous term at school, in order to maintain consistency in the modelling process. The resulting final model for T1 (holidays) was a good fit with the data (CMIN/DF = 2.20, RMSEA = 0.06, CFI = 0.92), and is displayed in Figure 7.

*Figure 7. Model 2: Final Model for T1 (holidays).*
As displayed in Figure 7, there were no direct links observed between the sleep duration measures and any other variables. The model showed a direct link between those who had lower scores on the DFS during the holidays, and lower grades in the previous term at school. Indirect links were also noted between sleep quality, circadian preference, and mood in the holidays with previously achieved grades at school, suggesting that those who did not report doing well at school tended to experience more negative mood, impaired functioning, and poorer sleep quality in the holidays, and also tended towards eveningness. The model was once again fitted to the girls’ and boys’ data separately with no significant advantage found in allowing the unstandardised coefficients to differ for boys and girls ($F(7,28) = 1.43, p > .05$). This indicated that the same model was appropriate for both boys and girls, although standardised coefficients differed slightly. These parameter estimates for the T1 (holiday) model are shown in Table 13.

Table 13
*Estimated Standardised Coefficients and Significance Values for the Final T1 (holidays) Model.*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Link</th>
<th>P-Value for Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>SMFQ</td>
<td>W3</td>
<td>0.000</td>
<td>Boys: 0.38, Girls: 0.37</td>
</tr>
<tr>
<td>SM/ES</td>
<td>SMFQ</td>
<td>W6</td>
<td>0.002</td>
<td>Boys: 0.16, Girls: 0.14</td>
</tr>
<tr>
<td>SMFQ</td>
<td>DFS</td>
<td>W1</td>
<td>0.000</td>
<td>Boys: 0.34, Girls: 0.37</td>
</tr>
<tr>
<td>SMES</td>
<td>DFS</td>
<td>W2</td>
<td>0.000</td>
<td>Boys: 0.19, Girls: 0.18</td>
</tr>
<tr>
<td>Quality</td>
<td>DFS</td>
<td>W4</td>
<td>0.000</td>
<td>Boys: 0.31, Girls: 0.34</td>
</tr>
<tr>
<td>DFS</td>
<td>Grades</td>
<td>W5</td>
<td>0.000</td>
<td>Boys: 0.17, Girls: 0.22</td>
</tr>
<tr>
<td>e6</td>
<td>e3</td>
<td>C1</td>
<td>0.000</td>
<td>Boys: -0.66, Girls: -0.69</td>
</tr>
</tbody>
</table>

*Note: n = 369; Female n = 240; Male n = 129; SMFQ = Short Mood and Feelings Questionnaire; DFS = Daytime Functioning Scale; SMES = Superscience Morningness/Eveningness Scale.*
As seen in Table 13 there was very little difference in the beta weights for girls and boys at T1 (holidays), and the strength of the direct pathways from SMES scores to SMFQ and DFS scores were weak. This indicated a weak direct effect of circadian preference on mood and daytime functioning, with more of a morning preference being weakly linked to higher mood and functioning at T1 (holidays). The direct links from sleep quality to mood and daytime functioning were similar in strength, with sleep quality also contributing in an indirect way to function via its direct effect on mood (girls indirect effect $\beta = 0.14$, boys indirect effect $\beta = 0.12$). This model also illustrates that at holiday time sleep quality was not influenced by any of the variables of interest in this study.

Finally, in order to model the impact of school term schedule on the changes observed in sleep variables, mood, and daytime functioning, and to examine the influence of trait circadian preference on these changes, a slightly modified Model 1 was fitted to the change data (T1–T2 data). In this model, the T1 (holiday) scores for the SMES were used as the baseline measure for circadian preference. Preliminary data analysis established that there was no significant difference between T1 (holidays) and T2 (school term) scores for this measure, and that it could be characterised as a trait measure of circadian preference. Accordingly, the scores collected at T1 (holidays) were thought to capture the baseline measure when students were feeling more able to set their own schedules and more able to follow their own natural circadian rhythm. The T2 (school term) measure of grades was also included in this model to maintain consistency, but as a change in grades from one school term to the next could not be regarded as due to the impact of school scheduling, it could not be considered as a change variable. Besides being maintained in the model for the sake of consistency, it was included in order to investigate whether the magnitude of negative changes in sleep, mood, or daytime functioning measures over time were reflected in lower academic achievement. All other variables in this model were change data (T1 – T2). Appendix S contains the means and standard deviations for the change variables.

Model 1 was fitted to the combined data, with the indices suggesting a reasonable fit with the data (CMIN/DF = 1.89, RSEA = 0.06, CFI = 0.96). It was then fitted separately to the boys and girls data using the same weights and covariances. This model was also found to be an acceptable fit with the data (CMIN/DF = 2.04, RMSEA
= 0.06, CFI = 0.96), but again, there was no significant improvement in the fit when different weights and covariances were allowed for girls and boys (F(18,16) = 0.84, p > .05), indicating that the same model was applicable to both groups. Table 14 shows the standardised coefficients and significance values for this model.

Table 14

Estimated Standardised Coefficients and Significance Values for Change Data (T1 – T2)

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Link</th>
<th>P-Value for Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM/ES</td>
<td>ΔSleep Debt W2</td>
<td>Boys</td>
<td>0.000</td>
<td>-0.23</td>
</tr>
<tr>
<td>ΔSleep Debt</td>
<td>ΔSleep Quality W1</td>
<td>Boys</td>
<td>0.040</td>
<td>-0.13</td>
</tr>
<tr>
<td>SMES</td>
<td>ΔWeekday TST W4</td>
<td>Boys</td>
<td>0.000</td>
<td>-0.25</td>
</tr>
<tr>
<td>SMES</td>
<td>ΔSleep Quality W8</td>
<td>Boys</td>
<td>0.064</td>
<td>-0.12</td>
</tr>
<tr>
<td>ΔWeekday TST</td>
<td>ΔSMFQ W6</td>
<td>Boys</td>
<td>0.458</td>
<td>0.05</td>
</tr>
<tr>
<td>ΔSleep Quality</td>
<td>ΔSMFQ W9</td>
<td>Boys</td>
<td>0.000</td>
<td>0.18</td>
</tr>
<tr>
<td>SMES</td>
<td>ΔSMFQ W16</td>
<td>Boys</td>
<td>0.835</td>
<td>0.01</td>
</tr>
<tr>
<td>ΔSMFQ</td>
<td>ΔDFS W3</td>
<td>Boys</td>
<td>0.000</td>
<td>0.28</td>
</tr>
<tr>
<td>ΔSleep Debt</td>
<td>ΔDFS W5</td>
<td>Boys</td>
<td>0.287</td>
<td>-0.06</td>
</tr>
<tr>
<td>SMES</td>
<td>ΔDFS W7</td>
<td>Boys</td>
<td>0.494</td>
<td>-0.03</td>
</tr>
<tr>
<td>ΔSleep Quality</td>
<td>ΔDFS W13</td>
<td>Boys</td>
<td>0.000</td>
<td>0.29</td>
</tr>
<tr>
<td>ΔDFS</td>
<td>Grades W14</td>
<td>Boys</td>
<td>0.703</td>
<td>-0.02</td>
</tr>
<tr>
<td>e6</td>
<td>e3</td>
<td></td>
<td>0.000</td>
<td>-0.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.73</td>
</tr>
</tbody>
</table>

Note: n = 307; Female n = 191; Male n = 116; Δ = Change (T1 – T2); SMFQ = Short Mood and Feelings Questionnaire; DFS = Daytime Functioning Scale; SMES = T1 Superscience Morningness/Eveningness Scale.

Table 14 displays some noteworthy non-significant coefficients. There is no direct relationship between SMES scores and changes in mood, as measured by the SMFQ, or daytime functioning, as measured by the DFS. However, SMES directly influences changes in weekday sleep and sleep duration, while its relationship with changes in sleep quality approached significance. Also of interest is the finding that
changes in sleep debt do not appear to influence changes in DFS scores, while changes in DFS scores have no direct relationship to grades at T2 (school term). In addition, no direct relationship was observed between changes in weekday sleep and changes in mood. These non-significant links were removed and the model resubmitted. The link between SMES and sleep quality was retained as this relationship approached significance, and was a theoretically meaningful link. The fit indices were examined and revealed a good fit with the data (CMIN/DF = 1.67, CFI = 0.94, RMSEA = 0.05). Figure 8 displays this modified model, while the parameter estimates are displayed in Table 15.

Figure 8. Model 3: Final Model for Change Data (T1-T2).
Table 15

*Estimated Standardised Coefficients and Significance Values for Final Change Model*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Link</th>
<th>P-Values for Unstandardised Coefficients</th>
<th>Standardised Coefficients</th>
<th>P-Values for Standardised Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM/ES</td>
<td>ΔSleep Debt</td>
<td>W2</td>
<td>0.000</td>
<td>-0.23</td>
<td>-0.25</td>
</tr>
<tr>
<td>ΔSleep Debt</td>
<td>ΔSleep Quality</td>
<td>W1</td>
<td>0.040</td>
<td>-0.14</td>
<td>-0.11</td>
</tr>
<tr>
<td>SM/ES</td>
<td>ΔSleep Quality</td>
<td>W8</td>
<td>0.064</td>
<td>0.12</td>
<td>0.10</td>
</tr>
<tr>
<td>ΔSleep Quality</td>
<td>ΔSMFQ</td>
<td>W9</td>
<td>0.000</td>
<td>0.19</td>
<td>0.21</td>
</tr>
<tr>
<td>ΔSMFQ</td>
<td>ΔDFS</td>
<td>W3</td>
<td>0.000</td>
<td>0.28</td>
<td>0.30</td>
</tr>
<tr>
<td>SM/ES</td>
<td>ΔWeekday TST</td>
<td>W4</td>
<td>0.000</td>
<td>0.25</td>
<td>0.27</td>
</tr>
<tr>
<td>ΔSleep Quality</td>
<td>ΔDFS</td>
<td>W13</td>
<td>0.000</td>
<td>0.31</td>
<td>0.38</td>
</tr>
<tr>
<td>e6</td>
<td>e3</td>
<td>C1</td>
<td>0.000</td>
<td>-0.673</td>
<td>-0.73</td>
</tr>
</tbody>
</table>

*Note: n = 307; Female n = 191; Male n = 116; Δ = Change (T2 – T1); Weekday TST = Weekday total sleep time; SMFQ = Short Mood and Feelings Questionnaire; DFS = Daytime Functioning Scale; SMES = SuperscienceMorningness/Eveningness Scale.*

As seen in Table 15, the direct link from SMES to change in sleep quality only approached significance, therefore not supporting this proposed pathway. However, the direct link from SMES to change in weekday sleep was significant, indicating that students with an evening preference were more likely to experience a greater change in weekday sleep, with less sleep and increased sleep debt as a consequence of the impact of school schedule, re-affirming the findings from repeated measures ANOVA analysis (see 9.7). The results indicated that students who accrued greater sleep debts and larger negative changes to their sleep duration tended to rate their sleep quality as poor, and that this change in sleep quality in turn influenced negative changes on the DFS and SMFQ. The standardised coefficients also reveal that the strongest direct relationships in this model (see Figure 8) were observed in the influence of changes in sleep quality on changes in daytime functioning, as measured on the DFS. Following this, the next
most important direct relationship was the influence of mood, as measured by the SMFQ, on the DFS scores. The variable grades at T2 (school term) was not influenced by the magnitude of changes in other variables, and as such, was superfluous to the model. These data suggest that circadian preference does not directly influence changes in outcome measures with the impact of school term, but rather, circadian preference moderates these changes through the influence of this trait on sleep variables, which in turn influence changes in sleep quality, which then directly affect changes in mood and daytime functioning.

The results of the structural equation models suggest that, during the holidays, circadian preference had no direct effect on sleep duration, sleep debt or sleep quality, and that sleep duration and sleep debt had no effect on the quality of sleep, or mood and daytime functioning. However, sleep quality and circadian preference were significant predictors of mood and daytime functioning. For the holiday model, sleep duration and sleep debt contributed nothing to the modelling of the sample data, suggesting that these variables should have been removed. Although grades at T1 (holidays) were retained in the model for consistency with the school model, it could be seen that there was a direct link from daytime functioning to grades, indicating that participants who enjoyed greater daytime functioning during the holidays had also reported that they achieved higher grades at school in the previous term.

The change model (see Figure 8) indicated that individual circadian preference did not directly impact on the changes in mood and functioning that were observed when students were scheduled by school. However, as anticipated, circadian preference indirectly affected the changes in these outcome measures through its influence on changes in sleep duration and sleep debt, which in turn influenced changes in sleep quality and mood and function. The school term model (see Figure 6) reflects aspects of both the holiday and change model. The weak direct effects of circadian preference on mood and functioning that were found at holiday time are illustrated, with the addition of the indirect links with mood and daytime functioning that were revealed in the change model. Furthermore, at school time, the indirect links that circadian preference has with grades can be seen. It appears, that with the impact of school schedule, those with an evening preference obtain less sleep, accrue larger sleep debts, and suffer lower quality of sleep than those with a morning preference. In addition to
the weak associations that evening preference already demonstrates with lowered mood and function at holiday time, the impact of school term effects even more negative changes on mood, function, and grades through the influence of circadian preference on sleep variables for this group of students.
Chapter Ten: Discussion

10.1 Overview

In this chapter the results of the current project are discussed. The first part summarises the results in terms of the general aims of the study and then in relation to the specific research questions and hypotheses that were outlined in Chapter Seven. As well, the relationship of the current findings with previous research is discussed. Next, the implications of the findings from the research project are considered in terms of the educational and clinical consequences of sleep during the final two years of school. Methodological issues are then addressed and suggestions presented for future research and validation.

10.2 Summary of Research Findings in Relation to Aims of the Study

One of the primary aims of the present study was to contribute some Australian data to the field of adolescent sleep patterns research. A further aim was to compare the sleep patterns of senior school students at holiday and school term in relationship to outcome measures of mood and performance. These current results are consistent with the reported trends in the area at both school time and holiday times. Young people slept for considerably longer during the holidays than at school term. As well, the results provide support for possible causal relationships. With the impact of school term, adolescents reported insufficient sleep for their needs, with lowered mood and daytime functioning as an apparent consequence of this. The results also suggest that poorer academic performance due to these factors is a further consequence.

Another aim of the research project was to more clearly delineate between the symptoms of depression and the experience of sleep difficulties, and also to expand on the problem daytime behaviours that have previously been measured. As a result of this, more definitive associations have been found that link sleep variables with the cognitive and affective aspects of depressed mood, and a wider variety of negative daytime functioning issues that were identified from the literature. Accordingly, the present study provides good evidence that sleep variables, such as low sleep quantity and quality are not only associated with daytime sleepiness, but also with complaints of lack of concentration and focus, memory problems, difficulties with decision making, irritability with others, difficulty controlling emotions, and feelings of demotivation and
lethargy. Additionally, the present study included a measure of sleep quality which was operationalised to be in line with the literature that characterises this construct as comprising subjective satisfaction with sleep duration and self-ratings of quality, as well as the absence or presence of particular sleep difficulties (e.g., difficulty initiating sleep). Previous work has included difficulty falling sleep along with daytime problems (e.g., arriving late to class, or falling asleep in class), as well as including reference to sleep difficulties in the measurement of depressed mood (Gianotti et al., 2002; Wolfson & Carskadon, 1998). The inclusion of a discrete measure of night-time sleep quality in the present study has allowed analyses that more clearly delineated between nocturnal sleep and daytime behaviours, showing unambiguous links between sleep quality and mood, and links with other daytime functioning problems such as irritability, and trouble remembering things, as well as daytime sleepiness. Moreover, the use of this measure showed that sleep quality was a more important predictor of mood and daytime functioning than sleep quantity.

It was also intended that the study would provide some information about the prevalence of sleep difficulties, as well as the reasons students thought might be causing these problems, and the issues they believed to be responsible for insufficient sleep. Accordingly, the current work provided some interesting insights from the students that might be useful as a basis for further investigations.

Additionally, investigations were conducted to assess whether evening typed in comparison to morning typed students were more vulnerable to lower sleep duration and regularity as a result of the impact of school term. Good evidence was provided that evening type students found it more difficult to adapt to the school schedule, and were more prone to obtain less sleep and higher sleep debt than the morning typed students. This was shown to occur over and above the negative consequences that were found for the sample as a whole due to the impact of school term. The implication is that an evening preference is an added vulnerability for depressed mood, impaired daytime functioning, and performance, due to the problems that this group has in obtaining sufficient sleep at school time.

Furthermore, data from this sample was modelled in order to test the theoretical perspective that circadian preference has an indirect effect on the outcomes of mood,
daytime functioning and grades through the effect of this trait on sleep. Several insights were thus provided into the complex relationships between circadian preference, sleep, mood, daytime functioning and grades, indicating both indirect and direct pathways of influence. Importantly, this theoretical model of the effects of sleep variables on well-being outcomes was not shown to be applicable at holiday time. This suggests that when adolescents are largely able to self-select their sleep schedules, individual differences in circadian preference have a less dramatic effect on daytime functioning and performance.

A number of specific hypotheses and research questions were investigated for this study and these are considered in turn.

10.3 Comparison of Holiday and School Term Sleep Habits

As hypothesised, students were found to obtain significantly less sleep at T2 (school term) than they did at T1 (holidays), particularly during the school week, obtaining on average, about 1 hour, 17 minutes less sleep time. Also as expected, students tended to wake up considerably earlier to accommodate the start of school. In the present study, students woke up about 2 hours, 30 minutes earlier at school time, and, also as anticipated, demonstrated larger variability between weekend and weekday sleep patterns during T2 (school term) compared with T1 (holidays). These findings were in accordance with those of Hansen et al. (2005), Palazzolo et al. (2002), and Szymczak et al. (1993) in their comparisons of holiday and school term sleep patterns in the US, France and Poland. The results clearly showed that students tended to adopt a later sleep/wake phase over the holidays by tending towards later bedtime and markedly later wake up times, particularly during the week. This is compatible with the view that adolescents as a group tend to be quite “evening typed” in their sleep patterns (Andrade et al., 1992; Carskadon & Acebo, 1992; Carskadon et al., 1993; Gau & Soong, 2003; Laberge et al., 2001; Shinkoda et al., 200).

At both holiday and school times students consistently reported that they ideally needed about 8 hours, 45 minutes sleep. This was exceeded during the holidays with students sleeping for about 9 hours, 12 minutes on weeknights, thereby not experiencing any sleep debt. However, the average amount of reported sleep need was not achieved by the students during school term, with an average sleep time of just under 8 hours per
school night, thus accruing considerable sleep debts. However, weekend sleep duration was consistent at both school term and holidays. This indicated that students tended not to catch up on sleep debt on the weekends at school time. It is possible that students’ weekend commitments remained the same as at holiday time (e.g., jobs, sport), thus not allowing extra opportunity for sleep.

It is interesting to note that the weekday sleep of the students at holiday time was the same as the optimal time suggested by Carskadon et al. (1980), and more than students said they ideally needed. The summer holidays of 2003, when this study began, was notable for the hot weather experienced, with consistently high temperatures and three nights over the data collection period that did not get below 20º C. Despite these uncomfortable sleeping conditions and early rise of the sun, students managed to sleep for about the same duration that was observed by Carskadon et al. in their study under ideal laboratory conditions of constant temperature and low light. The inconsistency between the amount of sleep that students said they needed, and the amount of sleep they obtained during the holidays, might reflect the lack of education about the sleep needs of adolescents. Perhaps students underestimated their ideal sleep needs and tended to reflect the widely held community attitude that 8 hours of sleep per night is an optimal amount. The adolescents in the present study said they required less sleep than adolescents in Europe and the US reported that they needed (Gianotti et al., 2002; Wolfson & Carskadon, 1998), and a little longer than the 8 hours, 24 minutes estimated by Japanese senior high school students (Takemura et al., 2002).

Students also tended to sleep for longer during the week than at the weekend during the holidays, possibly due to weekend jobs or sporting commitments that required them to arise earlier on weekends. This was reflected in the negative values for weekend oversleep, indicating that the students tended not to sleep in longer on the weekends at this time point. While they tended to go to bed later on the weekends, this was only about 46 minutes later than weekday bedtimes. The finding that less variability was noted between weekday and weekend sleep patterns in the holidays as compared to school term suggests that holiday sleep patterns were more regular and in keeping with adolescents’ naturally preferred rhythm as suggested by Palazzo et al. (2000).
In contrast to the holiday findings, students reported considerable daily sleep debts at school time, largely due to the changes in waking times to accommodate the start of school. While the finding that weekday sleep duration averaged about 7 hours, 55 minutes was well below the suggested sleep requirements of this age group (Carskadon et al., 1980), it was somewhat higher than the 7 hours to 7 hours, 6 minutes obtained by senior high school students in the US (Hansen et al., 2005; Wolfson & Carskadon, 1998), and the even shorter sleep times in Asian countries (Takemura et al., 2002; Yang et al., 2002), but similar to findings in Europe (Gianotti et al., 2005; Ohayon et al., 2000). This may be explained by the earlier school starting times reported for the studies in the US and Asia (between 7:10 to 7:30 a.m.), compared with the starting times of 8:30 a.m. for the present sample. Australian students wake up later than US students (7:04 a.m. versus 6:10 a.m.). Cultural differences may also account for differences in nocturnal sleep duration between Australian and Asian students. For example, it is common for Korean students to attend night school as well as day school (Yang et al., 2002), and intense academic competition in Taiwan has been forwarded as one of the main reasons students in this country sleep for less time than students in Western countries (Gau & Soong, 1995).

Most of the other sleep parameters at school time were fairly consistent with findings in the US and Italy for students of a similar age group (Gianotti et al., 2002; Wolfson and Carskadon, 1998). For example, students tended to go to bed on school nights at about 10:45 p.m., delayed their weekend bedtimes by about 1 hour, 38 minutes, and obtained about 8 hours, 50 minutes sleep on the weekends. Italian and Australian students exhibited about the same amount of weekend oversleep (55 minutes) compared to the longer sleep-ins for the US students (1 hour, 35 minutes). This might be interpreted as the American students requiring more of a catch up on sleep on weekends than their counterparts in Italy and Australia who tended to obtain more sleep during the school week. However, patterns of part-time work, and the propensity for Australian students to be involved in sporting fixtures on Saturday mornings might also explain the shorter weekend sleep-ins in the current sample. Together, these results indicated that sleep patterns in this Australian sample were remarkably similar to trends noted overseas, however, similarly to European students, the current sample tended to obtain more sleep than their counterparts in the US due to later school starting times.
10.4 School Related Differences in Measures of Substance Use, Sleep Quality, Daytime Functioning, Mood, and Grades

With the impact of school schedule, the students tended to experience more depressed mood, reporting increased feelings of unhappiness and anhedonia, and tended to endorse more negative beliefs about themselves, such as: “I hated myself”; “I felt I was no good any more”; and “I was a bad person”. They also experienced more impaired daytime functioning, reporting trouble waking up in the morning, sleepiness during the day, irritation with others, problems controlling emotions, and increased complaints of lethargy and low energy. The use of substances was less than in the holidays however, with findings of decreased alcohol use during school term. This may be attributed to decreased social opportunities during the week due to the requirements of school and homework. Instead, students consumed more soft drinks with caffeine. Self-reported grades were included at both time points to maintain consistency in the surveys, and the results showed that students said they maintained similar levels of academic achievement from one year to the next. Subjective sleep quality also remained the same at both holiday and school times.

These results are the first longitudinal type data from a field study that provides measures of both holiday and school term outcome data, along with the retrospective sleep parameters that were collected with the sleep diaries. Thus, this work has extended on Hansen et al.’s (2005) holiday versus school term design, by collecting holiday outcomes which could be regarded as baseline measures, taken when students were more able to self-select their sleep schedules. This has allowed inferential analysis of the impact of school term sleep habits on daytime performance in the current study. However, it must be noted that many students still had commitments during the holidays that possibly prevented them from keeping to their preferred sleeping schedule. Some had holiday jobs; some took part in sporting camps; and some were on family holidays away from home; and these factors would have impacted on these students’ ability to keep completely to their own preferred timetable.
10.5 Subjective Sleep Quality, Prevalence of Sleep Difficulties, and Perceived Reasons for Difficulties and Insufficient Sleep

Investigations into subjective sleep quality, sleep difficulties and the students’ perceived reasons for sleep problems and insufficient sleep provided an interesting insight into a number of issues pertaining to adolescent sleep. While overall scores on the Sleep Quality Scale (SQS) remained consistent over time, the pattern of responses changed from holiday to school time. Surprisingly, more students indicated that they experienced particular sleep difficulties during the holidays rather than school term. About 10% more students tended to take longer than 30 minutes to fall asleep at night, experienced more than 2 to 3 night wakings per night, and experienced more than 2 to 3 episodes of early morning waking over the surveyed time period. While no specific hypotheses had been made about sleep difficulty, it seemed reasonable to envisage that when students were more able to select sleep patterns, and were not pressured by school requirements, that they would experience less difficulties.

These current findings to the contrary might be explained within the context of the environmental conditions during the survey period. As noted before, the weather conditions during the survey period were very hot, and this is also reflected in the students’ responses as to why they thought they experienced these particular sleep difficulties. The most frequent response to this item was that they felt “too hot, cold, or uncomfortable”. In light of the temperatures at this time, it could safely be assumed that feeling uncomfortable due to the heat was responsible for the majority of sleep difficulties at holiday time. In very hot sleeping conditions it may be expected that people would have trouble getting off to sleep and staying asleep. With the early rise of the sun in the summer holidays it could also be expected that many students who did not have block-out blinds would complain of “early morning waking”, as for students on holidays, being woken by the sun at about 7:00 a.m. may very well be construed as the early hours of the morning.

Other less frequent responses to the question of why students felt they experienced particular difficulties were about not feeling tired, and worrying about personal problems. These responses provide some tentative support for the proposals by several researchers that circadian rhythm factors can result in young people not feeling tired at an appropriate time for sleep (Carskadon, 1999; Dahl & Lewin, 2002;
Gianotti et al., 2002; Millman, 2005), and also that emotional arousal interferes with sleep onset (Dahl et al., 1996).

At school time the frequency of reported sleep difficulties seemed comparable to the frequencies obtained previously in Australia by Bearpark and Michie (1987) who conducted research into sleep difficulties with a sample of students aged between 10 to 17 years. Similarly to these researchers the present study found that about 28% of students estimated that it took them longer than 30 minutes to fall asleep, and about 18% complained of waking in the night and early morning. However, it is difficult to compare these results with other studies due to the different methods of operationalising sleep difficulties and reporting results. It does seem apparent though, that sleep difficulties are a fairly common experience for this age group, as demonstrated by several other studies (Mantz et al., 2000; Meijer et al., 2000; Morrison et al., 1992; Ohayon et al., 2000; Waters et al., 1999).

It is also notable that at school time the two most frequently perceived reasons for sleep difficulties were “worrying about personal problems” and “worrying about school”. Although in Gau and Soong’s (1995) study with junior high students the most frequent reason given for poor sleep was “unknown” - tension, worry and school problems were also frequent responses in their study. It seems that the pressure to achieve at school along with possible family or peer related issues are areas that are deserving of more attention in regards to poor sleep for students. This finding suggests that school-based interventions targeting this type of cognitive arousal may be beneficial to students in the final years of school. A similar number of students also suggested that the reason they had problems with getting off to sleep was that they were simply not tired, providing evidence that for some students they become quite alert in the evening and are unable to get off to sleep at a reasonable hour, and further supporting the notion that later circadian phase contributes to students’ feeling alert at night and thus experiencing problems initiating sleep due to this.

Open-ended items about perceived reasons for sleep difficulties also yielded some interesting insights. Not being able to get off to sleep due to “active mind/thinking/reflecting” emerged as an important issue for adolescents. They did not regard this as “worry” as they did not endorse this reason, but indicated that this was
quite distinct from this negative type ruminative activity. One student explained that she was so busy during the school day that she rather looked forward to this time before sleep to reflect and contemplate on the day’s activities and interactions with others. She did not regard this in a negative light at all, pointing out the enjoyable aspect of the activity. This was reiterated by several other students, indicating that a longer sleep latency may, in some cases, not necessarily be attributable to negative behaviours or perceptions. Several students also indicated in the open-ended items that they received mobile phone calls that prevented them from getting off to sleep. Van den Bulck (2003) has provided evidence that over half of the 16-year-old participants in his study reported being woken by mobile phone calls. It seems that this phenomena could be worthy of further investigation.

At both holiday and school times it seemed that environmental factors, such as feeling uncomfortable due to heat or cold, or bothered by noise or light, and physical factors such as feeling unwell, were more important perceived reasons for waking in the night and early morning than worrying about personal problems or school. Many students commented in the open-ended questions about the influence of a variety of animals on their sleep problems, with mosquitoes, possums, and household pets referred to as annoying and disruptive in respect to maintaining sleep. These findings suggest that students may benefit from education about the importance of their sleeping environment in promoting restful, good quality sleep.

While students reported less sleep difficulties at school term, dissatisfaction with the amount of sleep they obtained was dramatically increased. The majority of students complained that they did not get enough sleep. This finding of an overlap between sleep quality and quantity was similar to findings in other research with university students where quantity of sleep was found to influence subjective ratings of sleep quality (Hawkins & Shaw, 1992; Medeiros et al., 2001).

It could be argued that for adolescents, the opportunity for sleep might be a very important factor in how they view the overall quality of their sleep. The present finding might also indicate that students express dissatisfaction with sleep due to having to alter their sleep patterns from their preferred natural rhythm. As noted earlier, the students in the current study were waking, on average, about 2 hours, 30 minutes earlier during the
week to accommodate school. This considerable change to their preferred holiday waking times might be quite an influence on their perceptions of the overall quality of their sleep.

In regards to obtaining insufficient sleep, students said that the main reason was because they stayed up too late, with having to get up too early cited as the next most important reason. Students said that they stayed up too late socialising, watching television, using the computer, reading, and at part-time jobs at both holidays and school time. During school an additional reason was homework demands. These findings are similar to those of Yang et al. (2004). Gau and Soong (1995) found that for their junior high sample in Taiwan the main reason students stayed up too late was due to homework and exam preparation, with similar reasons to the above mentioned less frequently. This difference in findings perhaps highlights the cultural differences between these two countries in regards to educational practices.

Unsurprisingly, the majority of those who complained of having to get up too early cited job commitments during the holidays, and school start time during the school term as the main reasons for their lack of sleep, followed by early morning sporting and extra-curricular practices. Interestingly, at both times 12% of the sample said they obtained insufficient sleep due to sleeping badly. This is entirely consistent with the percentage of students who rated their sleep quality as poor on the SQS, indicating some support for the validity of this scale. This finding suggests that sleep difficulties are not regarded as a major reason by adolescents for their lack of sleep, although it seems that for a proportion of students it is a considerable problem. Rather, the present results indicate that students believed scheduling factors were the main reasons for them obtaining insufficient sleep. These scheduling factors seemed to be due to both behaviour that was under students’ own control, such as watching television until late evening, and the externally imposed factor of school starting time.

10.6 The Relationship Between Circadian Preference, Sleep Variables, Sleep Quality, and Substance Use

By assessing circadian preference at both holiday and school times, the present study has provided a fuller picture of those students who have an evening orientation.
The hypothesis that no gender differences would be found in circadian preference was not supported, with the finding that boys more than girls tended towards eveningness not compatible with previous research with adolescents of a similar age group (Gianotti et al., 2002; Takehuchi et al., 2002). While some earlier studies with children and young adolescents (age 10 to 13 years) suggested that girls were more evening oriented than boys, this was found to be accounted for by the girls attaining higher pubertal scores than the boys (Carskadon et al., 1993; Laberge et al., 2002). The present finding is more in line with adult studies that have shown that males tend more towards eveningness than females on morningness-eveningness scores (Adan & Natale, 2002; Vink et al., 2001), and also that females have been found to be phase advanced in comparison to males in regards to melatonin acrophase (Gilbertini et al., 1998).

Roenneberg et al. (2004) studied the distribution of chronotypes across age groups and explained that although individuals tend to maintain their position within the distribution in relation to other individuals, there are chronotype changes related to age over the lifespan. Children are more morning typed and tend to become more delayed through adolescence. Their results show that girls become more delayed than boys during early adolescence due to their tendency to mature earlier than boys, and their preference for delayed phase appears to peak earlier than boys (at about 19 years, 6 months). Their research shows that young men tend to maintain this delayed phase until later than young women (about 21 years), and that they tend to be more delayed than women throughout adulthood. Adan and Natale (2002) have proposed that a different reciprocal action between the circadian pacemaker and sleep/wake processes for males and females could result in males becoming more evening typed. These authors go on to argue that the circamensual rhythm of females may impact in some way on this tendency toward more of a morning orientation in comparison to males.

The hypothesis that at school time evening preference would be associated with greater reported need for sleep, poorer sleep quality, later bedtimes and wake times, shorter school night sleep duration, higher sleep debt, longer weekend sleep time, more irregular sleep patterns, and higher substance use was partially supported. Except for the present finding of no significant link between eveningness and weekend delay (sleep irregularity), sleep need, or substance use, these findings concurred with prior research by Gianotti et al. (2002), and Mercer et al. (1998).
Nonetheless, the current findings suggested that even though evening types didn’t say that they needed more sleep than those of a more morning preference, they were less likely to obtain the sleep that they said they needed during the school week, and to sleep in on the weekends. This may also partly explain the association between eveningness and poorer sleep quality. It could be assumed that students with an evening orientation were less satisfied with their sleep duration at school time, tending to factor this in to their ratings of sleep quality. This perspective has been explored by Akerstedt, Hume, Minors, and Waterhouse (1994), who investigated the meaning of good quality sleep by measuring global sleep satisfaction and polysomnographic sleep measures in eight adult subjects. Their findings suggested that when sleep terminated close to the circadian acrophase (temperature rise), sleep quality was rated as high, and that sleep continuity was also associated with higher ratings of quality. From this it could be speculated that evening oriented students expressed more dissatisfaction with their sleep quality due to having to wake considerably earlier than their body clock indicated, possibly before the temperature acrophase, compared to those with a morning preference.

Although there was a tendency for students with an evening preference to use a higher quantity of substances at school time than those who had a more morning orientation, this association did not attain the set significance levels and as such, this finding is contrary to expectations. Gianotti et al. (2002) found that evening types used more tobacco, alcohol, and caffeine than morning types during school term. These researchers suggested that evening types use more substances containing caffeine in order to counteract feelings of sleepiness during the day, and that this consumption might contribute to the experience of disrupted sleep in these students. This motivation for caffeine use has been verified by Cofer et al. (1999), with their finding that one of the most frequent methods of coping used by evening types to combat lack of alertness at school is to consume caffeine. It is also possible that alcohol use may be a form of self-medication to help with problems getting off to sleep, or, as suggested by Cofer et al., higher use of alcohol may be linked to evening types’ feeling more disaffected with school as a result of possible conflict about getting up for school, attending on time, and continued difficulties regarding alertness and academic performance during the day. These researchers have suggested that eveningness might be an important influence on the development of anti-social tendencies and risk taking activities due to these
continued problems in adapting adequately to school. The present findings may well reflect unmeasured differences between this sample and others. For example, issues such as increased parental control over social activities during school term, homework load, or differences in achievement motivation at school may account for this lack of concurrence with Gianotti et al. (2002) in regards to substance use during school term.

Support was also found for the prediction that eveningness would be associated with later bedtimes and wake up times for both weekdays and weekends during the holidays. Evening types tended to stay up later and sleep in until later as compared to those students who were more morning oriented, demonstrating their preference for a later sleep/wake phase. Additionally, for the holidays, evidence was found indicating that eveningness was not associated with poorer sleep quality, or more erratic sleep patterns (weekend delay and oversleep), and was found to be associated with longer sleep duration during the holidays, and more use of substances than those who tended towards morningness.

It appears that when adolescent evening types are not so restrained by schedules, such as school starting time, and have more freedom to choose their own sleep schedules, they extend sleep for longer than those with a morning orientation, consistent with studies conducted with adults (Medeiros et al., 2001; Taillard et al., 1999). Additionally, the present study provides evidence that when they have the opportunity to do this in the holidays, they don’t appear to have sleep difficulties or dissatisfaction with their sleep, as they tend to at school time. Nor do they seem to exhibit the irregular sleep patterns that are so often commented on by researchers (Gianotti et al., 2002; Monk et al., 2004; Taillard et al., 1999). This implies that it is adapting to external schedules that is detrimental to the individual with an evening preference in terms of sleep quality, quantity and regularity.

In light of these findings about sleep patterns and eveningness during the holidays, it is difficult to explain substance use by the more evening oriented students only in terms of managing sleep difficulties or tiredness due to scheduling, as forwarded by Gianotti et al. (2002). Nor does it seem reasonable to speculate that higher substance use over the holidays by evening types was wholly due to managing negative feelings or low mood resulting from poor sleep habits and insufficient sleep. However, it seems
from further analyses discussed later in section 10.8, that evening oriented students tended to feel more depressed and impaired in functioning as compared to morning types at holiday time. Taking this into account, several hypotheses could be forwarded that might explain the higher use of substances in evening types at holiday time as well as the tendency towards this during school term.

Cofer et al.’s (1999) developmental perspective provides a very plausible explanation, within the context of evening types becoming disconnected from school due to problems adapting to a programme better suited to morning types. The implications of this are that these students would be more vulnerable to problems with self-esteem and depressed mood due to their compromised abilities to participate adequately in learning and achievement at school. This developmental pathway of continued low achievement and mood could result in substance use/abuse and increased risk taking behaviours both in terms of self-medication and the social milieu that evening types might gravitate towards, particularly during the holidays when parents might exert less control over their adolescent child. It might also be that the personality differences between circadian types that have been argued for by some researchers, influence a more maladaptive coping style, thus creating this propensity to experience lower mood and use more substances than morning oriented students (Caci et al., 1999; Mura & Levy, 1986). Moreover, it is also probable that substance use, mood and functioning are reciprocal in nature, as found by Tynjala et al. (1997) in their sample of adolescent boys.

An intriguing interpretation of the link between eveningness and substance use is that use of substances might be causal in the delay of the circadian phase of these individuals, in contrast to the theoretical perspective that eveningness influences the use of substances (Gianotti et al., 2002). For example, coffee consumption has been shown to decrease evening melatonin levels (Murphy et al., 1996; Shilo et al., 2002). Adolescents also tend to consume soft drink containing caffeine, and some beverages are available that contain a considerable dose of this substance (e.g., Red Bull). Sher (2003) proposed that it is possible that alcohol exposure during the prenatal period may impact on the suprachiasmatic nuclei, changing or disrupting the timing of the circadian sleep/wake cycle in infants. Other researchers suggest that alcohol might effect changes to the circadian clock through its impact on the brain and temperature disruption.
(Wasielewski & Holloway, 2001). As this area of research expands, new information might assist in explaining the link between substance use and circadian preference. Perhaps, as the adolescent brain is still developing, alcohol ingestion affects the circadian rhythms of young people, delaying the sleep/wake cycle. This line of research might also contribute further to our knowledge base on the harmful effects of substance use in young people.

10.7 The Influence of Trait Circadian Preference on Sleep Duration and Sleep Pattern Irregularity

Not only does the present study provide evidence that supports the view that adolescents as a group become more evening oriented, it also demonstrates that adolescents exhibit individual differences in circadian preference, supporting previous findings (Cofer et al., 1999; Gianotti et al., 2002; Roenneberg et al., 2004). The finding that scores on the Superscience Morningness/Eveningness Scale (SMES) did not change significantly over time attests to the notion that this preference can be considered trait-like, reflecting individual differences in biological circadian timing and preference for the timing of daily activities. As well, the finding that the SMES scores were approximately normally distributed demonstrates that students were arranged along the continuum from morningness, through a more neutral preference, to eveningness. The scores on the SMES were well correlated with bedtimes and wake times during the holidays in the present study, further reinforcing the validity of the scale as a measure of morning or evening preference.

Results from the mixed between-within ANOVAs indicated that there was an interaction between circadian preference and the change in schedule from holiday to school term for weekday sleep duration, and sleep debt, but not for the sleep irregularity measures of weekend oversleep and delay. These findings highlighted that, for evening types, sleep duration and sleep debt were more negatively affected at school term time as compared to holiday time (see Figures 1 and 2). This provides some empirical evidence for the assertions by researchers such as Cofer et al. (1999) and Gianotti et al. (2002) who have argued that school schedule has more detrimental effects on evening types than on morning types. The present study demonstrates that students with an evening preference slept more than morning types during the holidays when they were more able to self-select sleep schedules, and that this was reversed during school term,
with the imposition of school scheduling. It appears that evening types are additionally at risk for poorer sleep patterns at school time over and above the cohort effect of obtaining less sleep due to the change in schedules, which is at odds with their preferred timing for activities and optimal alertness.

For evening types, it is possible that they are feeling at their best later in the evening and tend to delay bedtimes due to this factor. As pointed out by Gianotti et al. (2002), it is also possible that evening types could not get off to sleep earlier to obtain more sleep even if they went to bed earlier, due to their intrinsic circadian phase being delayed, and the probability that they are simply not tired. What remains to be investigated more fully, is whether a delayed circadian phase, or eveningness, can be altered by gradually changing sleep habits. Carskadon and Acebo (1997) argue that it can be changed after their experimental work with enforced schedules and controlled light exposure. This showed that adolescents with later melatonin phase in the self-selected scheduling part of the experiment changed to an earlier melatonin phase after the enforced schedule, demonstrating an intrinsic change.

There have also been suggestions that evening types might be more sensitive to the effects of lighting on melatonin onset, tending to entrain circadian rhythm to a later phase or maintain it at a later phase (Carskadon, 1999). With evidence that non-photic stimuli might entrain circadian phase as well, it may require some considerable degree of self-discipline for an evening type adolescent to control substance use, lighting, music, internet and computer games, in order to try to alter their later phase to allow for more sleep during school time (Higuchi et al., 2003; Goel, 2005; Murphy et al., 1996; Shilo et al., 2002). It is possible that education about the importance of good sleep habits, as well as guidance from parents, might assist with some of these behavioural changes.

10.8 The Relationship Between Sleep Variables, Sleep Quality, Circadian Preference, Substance Use, Gender, and Mood and Daytime Functioning.

The correlation and regression results at school time were mostly consistent with previous findings by Acebo and Carskadon (2002), Gianotti et al. (2002), Mercer et al. (1998), O’Brien and Mindell (2005), and Wolfson and Carskadon (1998). As hypothesised, sleep variables, circadian preference, substance use, and gender were
significantly associated with the outcomes of mood and daytime functioning at school time. Shorter school night sleep times, poorer sleep quality, an evening preference, and female gender were associated with lower mood. However, contrary to Gianotti et al.’s (2002) previous findings, circadian preference was not found to uniquely contribute to the prediction of mood at school time.

With the addition of higher sleep debt, the same variables were also significantly associated with daytime functioning at school time. In accordance with Gianotti et al.’s (2002) findings regarding daytime sleepiness, the current study found that poor daytime functioning at school time was independently predicted by poorer sleep quality, higher substance use, an evening preference, and in addition, female gender and sleep debt. While it should be noted that the present study expanded daytime sleepiness to include other issues such as concentration, irritability, and decision making, and that sleep quality was used rather than sleep/wake problem behaviours as in Gianotti et al.’s (2002) study, these results are consistent in that an evening orientation seems to be a risk factor for poor daytime functioning. Inconsistent with previous research, sleep irregularity was not associated with either of the outcomes of mood and functioning at either time point (Gianotti et al., 2002; Wolfson & Carskadon, 1998).

Interestingly, while most of the associations remained consistent at holiday time for these outcomes of mood and daytime functioning, no links were found between sleep duration and sleep debt, further reinforcing the findings that the majority of students were satisfied with their sleep during the holidays. Poor sleep quality, on the other hand, was the most important predictor of mood and functioning at both holiday and school times, while sleep duration only independently predicted mood at school term. These results indicate that subjective sleep quality was more important than sleep duration in the present study. This finding is in accordance with previous work by Meijer et al. (2002) and Pilcher et al. (1997) who found that sleep quality was more important than quantity in predicting health, well-being and school functioning measures. It appears that perceptions and satisfaction with sleep and the presence of sleep difficulties are more important issues for adolescents in regards to mood and daytime performance than the relative amount of sleep they obtain.
10.9 The Relationship Between Sleep Variables, Sleep Quality, Circadian Preference, Substance Use, Gender, and Grades.

The expectation that self-reported grades would be significantly associated with, and predicted by sleep variables, circadian preference, substance use and gender at school time was supported. In accordance with previous research by Wolfson and Carskadon (1998), results showed that students who reported lower grades at school time tended to go to bed later on school nights, wake up later on school mornings, and report later weekend delays. Consistent with research by Gianotti et al. (2002), poorer grades were independently predicted by eveningness and higher use of substances. In addition, the current study supported Acebo and Carskadon’s (2002) finding that a longer weekend delay independently predicted lower grades at school time. However, contrary to Wolfson and Carskadon’s (1998) findings, no association was found between lower grades and lower sleep duration at term time. Nor was evidence found that weekend oversleep was associated with lower grades, inconsistent with findings by Gianotti (2002).

At holiday time, students who had reported lower school achievement tended to keep later wake times at this time point as well, and stay up later on weekends. Lower grades were independently predicted by male gender, higher substance use, and longer weekday sleep times, but circadian preference was not found to uniquely contribute to this.

10.10 Modelling the Influence of Circadian Preference on Sleep Variables and Outcome Variables at T1 (holidays), T2 (School Term) and for Change Data (T1 – T2).

The use of Structural Equation Modelling (SEM) allowed for a more comprehensive investigation of the complex interrelationships between sleep related factors and outcome measures of mood, daytime functioning and grades than has previously been undertaken. A primary goal was to illustrate the hypothesised influence of circadian preference on the outcome measures through the influence of this trait measure on sleep factors at T2 (school term) and to test these hypothesised relationships in regards to the current data set. A further aim of the modelling was to explore whether the same pattern of relationships applied to the T1 (holidays) and change data (T1 – T2).
The three SEMs generated several key findings. First, although boys in this current sample tended more towards eveningness than girls, the same model was applicable to both groups of students for each time point. While studies have varied in findings of gender differences in morningness/eveningness scores, results from this study suggest that the patterns of relationships were remarkably similar for boys and girls over time. No evidence was found in the current sample to support the view that sleep irregularity was an important factor in relation to mood, daytime functioning and grades, with neither weekend delay or oversleep attaining significance in the SEMs. Moreover, the school model did not accurately depict the holiday or change models, and consequently different models were developed for each.

For school time, the current study has shown that the relationships between the circadian preference, sleep variables, sleep quality, mood, daytime functioning and grades are more complex than those previously proposed, and provide support for both direct and indirect pathways of influence from circadian preference to daytime outcomes. A weak, direct link was observed between circadian preference and mood and daytime functioning, distinct from any influence of sleep factors. This was also applicable to the holiday data. Evening oriented students were more likely to report lower mood than morning oriented students, complaining of feeling miserable or unhappy, tending to hold negative views about themselves, and to experience anhedonia. They also tended to report more impaired daytime functioning, experiencing sleepiness, and irritability, difficulties with concentration and emotional control, and lack of energy during the day. As proposed by Gianotti et al. (2002) and Medeiros et al. (2001), circadian preference also had a direct effect on sleep quality at school time, which was not found to be present at holiday time. This suggests, as these researchers have postulated, that evening types may experience difficulties getting off to sleep when they go to bed at a time early enough to try to accommodate school schedule.

However, the link proposed by these researchers whereby poor sleep quality results in sleep deprivation and sleep debt was not supported in this sample. As hypothesised, the model provided evidence that circadian preference directly influenced weekday sleep duration and sleep debt, which affected ratings of sleep quality, and that this in turn affected mood and functioning. Perhaps if sleep duration was not part of the
sleep quality measure this result may have been somewhat different. Further research could test the model again by using a pure measure of nocturnal sleep difficulties in order to further evaluate the proposals by Gianotti et al. (2002) and Medeiros (2001). Regardless, it appears that perceptions of sleep quality, which overlapped to some degree with satisfaction with sleep duration, were important contributors to how students felt and behaved during the day at school.

As well, a pathway was revealed whereby circadian preference moderated weekday sleep and sleep debt which then directly affected mood and functioning. Students who were more evening oriented obtained less sleep and generated higher sleep debts, which in turn resulted in lower mood and more impaired daytime functioning. Importantly, this model also illustrated the indirect links that circadian preference had with grades, through its effect on mood and functioning. This finding supports previous work suggesting that insufficient and poor quality sleep affects students’ ability to concentrate and perform adequately at school, also affecting their mood, and subsequently affecting their academic achievement (Wolfson & Carskadon, 1998). This relationship between sleep duration and grades was obscured in the correlation analyses in the present study. Most notably the current work provides some support for the contention that sleep deprivation may be a causal factor in the development of depressed mood (Dahl & Lewin, 2002; Wolfson & Carskadon, 1998) both directly, and indirectly through its effect on sleep quality. Furthermore, the model illustrated that evening oriented students were more vulnerable to this pathway as asserted by Gianotti et al (2002). However, it must be acknowledged these links between sleep duration and mood are weak.

The holiday model emphasised that there was no link between circadian preference and any of the sleep variables (sleep quality, duration, or debt) at this time, and thus there was no support for the indirect pathway from circadian preference to mood and functioning through any of the sleep variables. However, in accord with the school model, weak direct links were found between circadian preference and mood and functioning at this time, suggesting a trait-like association. Sleep quality was the factor that had the major influence on mood and functioning during the holidays, and as illustrated in Figure 7, no other variables depicted in the modelling process were observed to impact on this variable. However, as previously discussed, results from
frequency analyses in the current study provide some good evidence that sleep difficulties were more influential in overall subjective ratings of sleep quality than perceptions about sleep duration at this time point. From this information it can be assumed that sleep difficulties, such as problems initiating and maintaining sleep, directly impacted on the students’ mood and ability to function well the next day, and that it was the hot sleeping environment that was seen to be the main cause of these difficulties.

In the change model it was apparent that circadian preference did not directly influence the decrements in mood and functioning that occur at school time. It was proposed that at school term, individual circadian preference would impact on sleep quality, sleep duration, and sleep debt, and that these would in turn influence the changes to the outcome measures. The results showed that the link suggesting that circadian preference directly influenced changes in sleep quality approached significance. However, the model revealed that more evening typed students experienced a greater change in weekday sleep, and accrued greater sleep debts as a consequence of the impact of school schedule. It was through this pathway that students experienced changes to sleep quality – evening oriented students who had larger sleep debts perceived their sleep quality to be worse, and this in turn effected a greater change in mood and daytime functioning scores.

The modelling process provided good evidence that insufficient sleep, sleep difficulties, and dissatisfaction with the amount of sleep obtained at school term contributes directly and indirectly to feelings of depression, daytime sleepiness, poor concentration, difficulties with decision-making, irritability with others, problems with emotional control, lethargy and demotivation, which in turn affects academic performance. Importantly, the models have provided considerable support for the proposals that with the impact of school scheduling, individual circadian preference indirectly impacts on mood, daytime functioning and grades through an effect on sleep quality and sleep duration measures (Gianotti et al., 2002; Medeiros et al., 2001). An evening preference has been shown to be an added vulnerability for negative outcomes when school term impacts on both the quality of sleep and the sleep/wake schedules of senior secondary students.
10.11 Implications of the Findings

The results of the present study indicate that sleep is a crucial aspect of adolescent health and well-being, with many young people obtaining insufficient or poor quality sleep, which may exact a heavy cost in the final years of secondary schooling. If day-to-day functioning is compromised due to inadequate sleep, the task of learning new material, consolidating memory, recalling information, solving problems creatively, and keeping up to date with the considerable work-load in these final years could become onerous and overwhelming. It might be expected that this would contribute further to the feelings of depression that have been shown in this study to be linked with poor quality and insufficient sleep. These factors make the achievement of success in the important final years of schooling extremely difficult, and could prevent young people from reaching their potential academically, as well as impacting on their health, along with their emotional and social development.

Additionally, the present study has identified that students with an evening preference may find it particularly difficult to adapt to the school schedule and to cope with changes to their preferred sleep/wake cycle. These students, who tend to stay up later and obtain less sleep than other students, tend to function poorly during the day and to be more vulnerable to lowered mood, daytime sleepiness, poor concentration and all the difficulties that this encompasses at school. Moreover, these students tend to be heavier consumers of caffeine, tobacco and alcohol during holiday time, and tend slightly more toward this during school term as well. This might be an attempt to medicate feelings of sleepiness and sluggishness during the day, or to promote relaxation and induce sleep at night. It is probable that these substances create even further difficulties, impacting on sleep latencies and the structure and quality of sleep, creating even more problems in day-to-day functioning, as well as the negative health outcomes that can be the result of substances such as tobacco and alcohol.

While the present study focused on day-to-day outcomes that were applicable to performing at school as well as emotional and social development, the implications of the work suggest that insufficient sleep and impaired functioning could also have consequences in respect to accidents and injury to young people, particularly as this age group has the opportunity to learn to drive and obtain a driving licence. It seems imperative that increasing the knowledge about adolescent sleep requirements in the
For educators, knowledge of the sleep requirements of this group, and the involvement of biologically mediated changes in sleep/wake phase, could be helpful in understanding how to best meet the educational needs of senior students. While school start times have not been the contentious issue that they have been in the US, there are increasingly more early morning classes being scheduled in Australia to accommodate the ever-broadening curriculum. The current study investigated three schools where the official start time was 8:30 a.m. However, many students indicated that they were involved in early morning practices, and it was found that, on average, students obtained insufficient sleep for their needs.

It could be extrapolated that students who are required to attend earlier classes could be further at risk of poor outcomes due to the difficulty they might experience in scheduling sleep. Further research is needed in this respect, particularly as some large “high demand” schools in Australia have begun to implement split shifts, with senior students starting even earlier, in order to better use stretched resources (Department of Education and Training, 2005). With increased knowledge about the importance of sleep in adolescence, schools may provide classes and practices for senior students at a time that is more suited to their concentration and alertness levels, opting for sessions later in the day rather than pre 9 a.m., allowing time for young people to obtain adequate sleep and be more able to meet the challenges of the day.

The finding that boys tended more towards eveningness than girls and also were more likely than girls to obtain poorer grades has some important implications in the education arena. In recent years some publicity has been given to the lower marks that boys have been obtaining in the V.C.E. (Victorian Certificate of Education) in comparison to girls. With the introduction of earlier classes at some schools it may be that boys are experiencing more difficulty than girls in adapting and coping with school requirements. A recent unpublished study conducted in Australia seems to support this view, with evidence that school start time was one of the best predictors of university entrance scores for boys, but not for girls, irrespective of type of school and socio-economic background. A difference in school starting times between 8:30 a.m. and 9
a.m. was found to result in a difference of 4 points, a considerable amount when considering the cut-off scores for university entrance (Cooper, N., personal communication, September 29, 2005). These findings seem worthy of further investigation, as circadian rhythms and the importance of developmental sleep requirements have been little recognised in the education of young Australians.

For health clinicians working with young people, the current project highlights the need to carefully assess sleep habits by using adolescent developmental needs as a reference point when managing patients who present with feelings of depression, substance use/abuse, poor academic performance, or who are generally not managing in their daily lives. The current study has highlighted that specific sleep difficulties, particularly problems getting off to sleep, are a fairly common occurrence in this group of senior students. During school term this complaint was likely to be seen by students as due to worry, or to the feeling of not being tired, indicating a desynchronisation between body clock and required bedtime. While it must be acknowledged that sleep difficulties may be an artefact of depression, and that bi-directional effects of mood and sleep are widely accepted, some researchers assert that sleep onset problems are more common than early waking in adolescent depression than in adults, and that difficulty getting off to sleep could be seen as an early warning symptom of depression (Dahl & Lewin, 2002; Dahl et al., 1996). In longitudinal work with adults, Ford and Kamerow (1989) have suggested that sleep problems may precede depression, and that early intervention for sleep difficulties may assist in the prevention of some psychiatric illnesses. The results of the current study indicate that cognitive arousal, such as worrying about school, or peer and family related issues, as well as physiological factors, such as delayed sleep/wake phase, are important issues to be addressed and treated in young people with sleep difficulties.

The present study has also underlined that sleep duration and subjective sleep quality, including satisfaction with sleep duration, also influence the outcomes of mood and daytime functioning with these factors in turn impacting on academic performance. It is possible that dissatisfaction with sleep quality arises from feeling that the sleep/wake cycle is somewhat displaced during school time, with evening typed adolescents being particularly vulnerable to this, finding it difficult to get off to sleep, obtain enough sleep, adjust to school, and perform during the day. Therefore, some
young people who present with depressed mood may benefit from careful assessment in regards to these interwoven factors, with strategies designed to assist them improve sleep habits, advance sleep phase and extend sleep duration.

Further research might provide more information as to how to best help students obtain more sleep during the school term, and particularly, what interventions might be implemented for evening types. As studies suggest that biological, behavioural, and social factors affect adolescent sleep, changes on several levels may be necessary to improve this aspect of young people’s lives (Allen, 1992; Carskadon et al., 1993; Carskadon & Acebo, 1997; Wahlstrom et al., 1998; Wolfson, 2002). Parents have a role to play in providing structure in the evening and ensuring time for adolescents to wind down at night by limiting television, internet, and phone use at an appropriate time. Further work may clarify the role that these distractions play in entraining circadian phase to a later phase when used in the evenings. Adolescents themselves might be better able to monitor their own behaviours and improve sleep habits if they become more aware of their own developmental sleep needs and the factors that might negatively influence and delay their sleep/wake phase.

10.12 Limitations of the Current Study

Several limitations were associated with this study. The sample was taken from only three schools in the metropolitan area of Melbourne, Australia, and due to the gender composition of the schools males and females were not equally represented. Therefore generalising the present findings to the broader Australian adolescent population must be tentative. Results of this study were based on self-report, retrospective surveys, and although past research has shown that sleep parameters collected in this manner are well correlated with actigraphy and daily sleep diaries (Wolfson et al., 2003), more objective methods of data collection may have improved the accuracy of the data. However, self-reports remain the most cost-effective and manageable method of conducting a project such as this. The survey asked students to recall their usual sleep habits over the past two weeks, and this task might have been easier for school term habits when students keep to a schedule, than for the holidays when there are less constraints on students’ time, and sleep habits might be more difficult to recall.
A further limitation was the low reliabilities demonstrated by the Sleep Quality Scale and Substance Use measure. The Sleep Quality Scale was developed for the present study by adapting five items from the Sleep Habits Survey (Wolfson & Carskadon, 1998) with a further item adapted from the Pittsburgh Insomnia Rating Scale (Moul et al., 2002). While this scale assessed sleep difficulties and subjective satisfaction with sleep, similarly to well validated but more complex scales such as the PSQI, the reliabilities were disappointing. Future research may further develop a measure of nocturnal sleep quality that is more reliable while also being attractive to adolescents.

Low reliabilities for the Substance Use measure have also been reported previously (Carskadon et al., 1991; Gianotti et al., 2002). While slightly better reliability alphas were found in the present study, with an item about sleeping medication replacing the one about illegal drugs, the five items making up the measure (assessing caffeine use, alcohol, tobacco, and sleeping medications) do not seem to measure a cohesive construct. Further work might assess these substances separately as categorical variables.

Furthermore, research has forwarded alternative methods of assessing circadian phase than the use of morningness-eveningness scales. The mid-point of self-selected regular sleep routines has been found to be reliable indicator of melatonin phase in young adults (Burgess et al., 2003), while the Munich ChronoType Questionnaire (MCTQ) has been developed to assess this also by asking about bed times, wake times and controlling for sleep need, on commitment free days (Roenneberg, Wirz-Justice, & Merrow, 2003). This method provides a time-based analysis of chronotype rather than an assessment that is scale based. In retrospect, this method could have been used to good advantage over the holiday period in the current study. However, the survey for the present study did not ask for students to elect a commitment free day for this base data to be collated. Nonetheless, morningness-eveningness scores were found to be well correlated with the mid point of average weekday sleep in the holidays.

Additionally, while the use of structural equation modelling has provided some valuable insights into the complex relationships between chronotype, sleep, and daytime functioning variables, it must be noted that there may be other equivalent models that
might also explain the data. Further research might test alternative models, particularly by utilising a measure of sleep difficulties only, without reference to satisfaction with sleep, in order to investigate more fully the theoretical perspective that eveningness promotes sleep difficulties which are causal in these students obtaining insufficient sleep at school time (Gianotti et al., 2002). A larger sample size would also be advantageous in future studies as the comparisons of separate models for girls and boys were not as powerful as desired. Moreover, it must be acknowledged that many other factors are involved in adolescent depression and performance, such as personality variables, ability levels, life events, stress, coping strategies, family factors, and level of motivation, and that future research might include some of these for consideration into the modelling process.

10.13 Conclusions

The purpose of this project was to present some Australian data on the sleep patterns of adolescents in the final two years of school, primarily by replicating previous research that has been conducted in other countries. It also intended to compare sleep patterns during the holidays with those of school term, and to compare daytime functioning at both these time points, investigating how these factors related to sleep patterns, thus extending previous research in this area. Additionally, the study aimed to investigate circadian phase, and assess whether individual differences in this trait influenced daytime performance measures indirectly through an effect on sleep patterns. A final aim was to model the proposed links between circadian preference, sleep variables, and outcome variables.

In addressing these issues, several contributions have been made to the adolescent sleep patterns literature. Evidence has been presented suggesting that Australian adolescents exhibit similar sleep patterns to school attending teenagers of a comparable age and year level elsewhere. The adolescents in this sample preferred a late sleep/wake phase when they had the opportunity over the holiday period, and obtained, on average, an optimal amount of sleep for their developmental needs, despite an uncomfortably hot summer break. At school term, sleep duration was compromised, mostly due to students needing to wake around two and a half hours earlier on school mornings to attend classes. The starting times of the schools that participated in this project appeared to be somewhat of a protective factor in regards to sleep duration,
when comparisons were made with the sleep times obtained in other countries with earlier starting schools.

While some studies have previously investigated daytime performance in regards to sleep, this project is the first to provide baseline measures that were collected at holiday time, and investigate how these changed during school term, finding that the mood of the group became lower and students were more likely to be experiencing difficulties functioning adequately during the day. Through the use of structural equation modelling, the study has been able to provide strong evidence that changes to sleep duration and perceived sleep quality were instrumental in these decrements in mood and functioning. Furthermore, grades were also affected through this pathway of poor sleep influencing mood and daytime functioning, although this relationship was obscured in the correlation analyses in the present study. Contributions were also made to the literature by highlighting that individual differences in circadian preference magnified these effects at school time. Evening type adolescents went to bed later, obtained less sleep, and complained of poorer quality sleep. These factors were clearly shown to impact on their mood, their ability to concentrate and function at school, and to achieve academically.

Finally, convincing evidence has been presented to indicate that sleep is a significant issue for adolescents. They report dissatisfaction with the amount of sleep they are reasonably able to obtain, given their heavy schedules in the final years of school. This has considerable implications for their health and well-being, with links between inadequate sleep and feelings of depression, poor concentration, poor memory, irritability, poor emotional control, and academic performance. With more widespread understanding of the important developmental requirements of this age group in terms of sleep, and the difficulties that they encounter in obtaining this, more strategies might be implemented by parents, schools, health professionals and adolescents themselves to improve sleep habits and subsequently – health, well-being, and the potential to achieve academically.
References


Appendix A

Holiday and School Term Surveys
Sleep Habits Survey 2003

We are now interested in your sleep habits over the holidays. All your answers are very important to us - please complete every question by putting a circle around the item that best describes your situation.

First, some general details about you.

1. Your age: ____________________

2. □ Female (circle or tick the box to indicate your answer)  
   □ Male

3. Are your marks in school mostly

   1 A’s  5 C’s
   2 A’s & B’s  6 C’s & D’s
   3 B’s  7 D’s
   4 B’s & C’s  8 D’s & E’s

4. What do you think is the ideal amount of sleep for you?

   ___________  hours per night
Thinking back over the **last two weeks of the holidays**, please fill out the sleep diary as accurately as you can. If you know you went to bed at very different times, for eg. 1 am for one Monday night, and 11 pm the next Monday, average it out to about midnight. If you are unsure, just give your best guess, but please fill in every box.

Work your way **DOWN** each column.

<table>
<thead>
<tr>
<th></th>
<th>Sunday Nights</th>
<th>Monday Nights</th>
<th>Tuesday Nights</th>
<th>Wednesday Nights</th>
<th>Thursday Nights</th>
<th>Friday Nights</th>
<th>Saturday Nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. About what time did you <strong>go to bed</strong>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. About how long did it take you to <strong>fall asleep</strong>?</td>
<td><em>Mins</em></td>
<td><em>Mins</em></td>
<td><em>Mins</em></td>
<td><em>Mins</em></td>
<td><em>Mins</em></td>
<td><em>Mins</em></td>
<td><em>Mins</em></td>
</tr>
<tr>
<td>7. About what time did you <strong>wake up the next day</strong>?</td>
<td><strong>Monday Wake up</strong></td>
<td><strong>Tuesday Wake up</strong></td>
<td><strong>Wednesday Wake up</strong></td>
<td><strong>Thursday Wake up</strong></td>
<td><strong>Friday Wake up</strong></td>
<td><strong>Saturday Wake up</strong></td>
<td><strong>Sunday Wake up</strong></td>
</tr>
</tbody>
</table>
8. Generally, how long did it take you to fall asleep?

<table>
<thead>
<tr>
<th></th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>As soon as my head hit the pillow</td>
</tr>
<tr>
<td>4</td>
<td>Less than 30 minutes</td>
</tr>
<tr>
<td>3</td>
<td>Between 30 minutes to 1 hour</td>
</tr>
<tr>
<td>2</td>
<td>Between 1 to 3 hours</td>
</tr>
<tr>
<td>1</td>
<td>More than 3 hours, or I didn’t sleep</td>
</tr>
</tbody>
</table>

9. Some people wake up during the night. Others never do. How many times did you usually wake up at night?

<table>
<thead>
<tr>
<th></th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Never</td>
</tr>
<tr>
<td>4</td>
<td>Once</td>
</tr>
<tr>
<td>3</td>
<td>2 or 3 times</td>
</tr>
<tr>
<td>2</td>
<td>More than 3 times</td>
</tr>
<tr>
<td>1</td>
<td>I have no idea</td>
</tr>
</tbody>
</table>

10. Over the last 2 weeks, did you find that you woke in the early hours of the morning and could not get back to sleep?

<table>
<thead>
<tr>
<th></th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Never</td>
</tr>
<tr>
<td>4</td>
<td>Once</td>
</tr>
<tr>
<td>3</td>
<td>2 or 3 times</td>
</tr>
<tr>
<td>2</td>
<td>Often</td>
</tr>
<tr>
<td>1</td>
<td>Everyday / night</td>
</tr>
</tbody>
</table>

11. In general, over the last 2 weeks did you feel you usually got ...

<table>
<thead>
<tr>
<th></th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Too much sleep?</td>
</tr>
<tr>
<td>3</td>
<td>Enough sleep?</td>
</tr>
<tr>
<td>1</td>
<td>Not enough sleep?</td>
</tr>
</tbody>
</table>

12. Did you consider your overall sleep quality to be ...

<table>
<thead>
<tr>
<th></th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Good</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>Poor</td>
</tr>
</tbody>
</table>
13. Over the last 2 weeks, how often did you think that you got enough sleep?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Always</td>
</tr>
<tr>
<td>4</td>
<td>Usually</td>
</tr>
<tr>
<td>3</td>
<td>Sometimes</td>
</tr>
<tr>
<td>2</td>
<td>Rarely</td>
</tr>
<tr>
<td>1</td>
<td>Never</td>
</tr>
</tbody>
</table>

14. On the days that you didn’t get enough sleep, what was the major reason? (tick only one that best describes your situation)

- This did not apply to me - I got enough sleep
- I had to get up earlier than I wanted
  (please state why eg. extra curricular activities, sport, family demands, job etc.)
- I stayed up too late
  (please state why eg. socializing, job, T.V., homework / study etc.)
- I slept badly

We are interested in the reasons why you think you might have experienced difficulties going to sleep or staying asleep over the last 2 weeks of holidays. If you never had trouble sleeping you can tick “does not apply to me” - but please, answer every question.

15. If you had trouble falling asleep over the last 2 weeks of the holidays what do you think was the main reason for this?

- This does not apply to me, generally I had no trouble falling asleep
- I wasn’t tired
- I was bothered by noise or light
- I was too hot / cold / uncomfortable
- I wasn’t well
- I needed to use the bathroom
- I was worried / concerned about personal problems
- I was worried / concerned about school
- Any other reasons?

___________________________________________________________________________________

___________________________________________________________________________________
16. If waking up in the night bothered you over the last 2 weeks of holidays, what do you think was the main reason for this?

☐ This does not apply to me, generally I did not wake up in the night
☐ I wasn’t tired
☐ I was bothered by noise or light
☐ I was too hot / cold / uncomfortable
☐ I wasn’t well
☐ I needed to use the bathroom
☐ I was worried / concerned about personal problems
☐ I was worried / concerned about school
☐ Any other reasons?

_____________________________________________________
_____________________________________________________

17. If you were bothered by waking up in the early hours of the morning and not being able to get back to sleep, what do you think was the main reason for this?

(Don’t include having to wake up early for job, sport, practices etc.)

☐ This does not apply to me, generally I did not wake in the early hours of the morning
☐ I wasn’t tired
☐ I was bothered by noise or light
☐ I was too hot / cold / uncomfortable
☐ I wasn’t well
☐ I needed to use the bathroom
☐ I was worried / concerned about personal problems
☐ I was worried / concerned about school
☐ Any other reasons?

_____________________________________________________
_____________________________________________________
18. **Over the last 2 weeks of the holidays, how often did you....**

(Tick one answer for every item)

<table>
<thead>
<tr>
<th></th>
<th>Everyday/night</th>
<th>Several times</th>
<th>Once or twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Feel satisfied with your sleep?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>Have difficulty waking up?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Feel sleepy during the day?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>Doze off or have a nap when you really didn’t want to?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>Have difficulty keeping your thoughts focused?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>F</td>
<td>Have difficulty remembering things?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>G</td>
<td>Have difficulty thinking clearly and making decisions?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>H</td>
<td>Have others tell you that you look tired and fatigued?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>I</td>
<td>Feel in a bad mood because of lack of sleep?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>J</td>
<td>Feel irritated with people even when they were polite?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>K</td>
<td>Have difficulty controlling your emotions?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>L</td>
<td>Have no energy because of lack of sleep?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>M</td>
<td>Feel you were only able to do enough to get by?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>N</td>
<td>Have difficulty getting along with others?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>O</td>
<td>Feel physically clumsy?</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

19. **During the last two weeks of the holidays, how often did you......**

(Mark one answer for every item)

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Once or twice</th>
<th>Several times</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Use tobacco (cigarettes, cigars)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>Drink coffee or tea with caffeine?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>Drink soft drink / energy drink with caffeine (Coke, Pepsi, Red Bull, Lift +, V, Red Eye, Red Dragon, etc.)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>Drink alcohol (beer, cider, wine, spirits)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>Use medication to help you sleep? (prescribed or over the counter)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
This section is about your moods and feelings over the past 2 weeks of the holidays.

<table>
<thead>
<tr>
<th>20. How true were each of the following statements for you over the last 2 weeks of the holidays? (circle one answer for every item)</th>
<th>True</th>
<th>Sometimes True</th>
<th>Not True</th>
</tr>
</thead>
<tbody>
<tr>
<td>A I felt miserable or unhappy</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B I felt I had a number of good qualities</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>C I didn’t enjoy anything at all</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>D I felt so tired I just sat around and did nothing</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E I was very restless (couldn’t sit still or quiet)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>F I felt I was no good any more</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>G I was able to do things as well as most people</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>H I cried a lot</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>I I found it hard to think properly or concentrate</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>J I hated myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>K I was a bad person</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>L I took a positive attitude toward myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>M I felt lonely</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N I thought nobody really loved me</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>O I thought I could never be as good as other people</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>P I did everything wrong</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Q I generally felt satisfied with myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
In this section we are interested in how you might organize the timing of various activities if you were free to plan your day according to when you feel your best. 

Please answer the questions based on your body’s “feeling best” times

21. Imagine school is cancelled. You can get up whenever you want to. When would you get out of bed? Between...

- 5 5.00 - 6.30 am.
- 4 6.30 - 7.45 am
- 3 7.45 - 9.45 am
- 2 9.45 - 11.00 am
- 1 11.00 - Noon

22. Is it easy for you to get up in the morning?
- 1 No
- 2 Sort of
- 3 Pretty easy
- 4 Easy

23. Sports practice is set for 7.00 in the morning. How do you think you’ll do?
- 4 My best
- 3 Okay
- 2 Worse than usual
- 1 Awful

24. The bad news: You have to take a two hour exam. The good news: You can take it when you think you’ll do your best. What time is that?
- 4 8.00am - 10.00 am
- 3 11.00am - 1.00 pm
- 2 3.00 pm - 5.00 pm
- 1 7.00 pm - 9.00 pm

25. When do you have the most energy to do your favourite things?

- 4 Morning. I am tired in the evening
- 3 Morning more than evening
- 2 Evening more than morning
- 1 Evening. I am tired in the morning
26. What time would you prefer to go to bed? Between:

- 5 8.00 - 9.00 pm.
- 4 9.00 - 10.15 pm.
- 3 10.15 pm. - 12.30 am.
- 2 12.30 - 1.45 am.
- 1 1.45 - 3.00 am.

27. How alert are you in the first half hour you’re up?

- 1 Out of it
- 2 A little dazed
- 3 Okay
- 4 Ready to take on the world

28. When does your body start to tell you it’s time for bed even if you ignore it? Between:

- 5 8.00 - 9.00 pm.
- 4 9.00 - 10.15 pm.
- 3 10.15 pm. - 12.30 am.
- 2 12.30 - 1.45 am.
- 1 1.45 - 3.00 am.

29. If you had to get up at 6.00 am. every morning: What would it be like for you?

- 1 Awful
- 2 Not so great
- 3 Okay (if I have to)
- 4 Fine, no problem

30. When you wake up in the morning how long does it take for you to be totally “with it”? 

- 4 0 - 10 minutes
- 3 11 - 20 minutes
- 2 21 - 40 minutes
- 1 More than 40 minutes
In this section, we’d like to get an idea about how busy you were with scheduled activities during the past two weeks of the holidays.

### My Activities during the Holidays

31. Thinking back over the last 2 weeks of the holidays, fill out how many hours you generally spent doing the following activities...

<table>
<thead>
<tr>
<th>Activity</th>
<th>About how many hours per week</th>
<th>Does not apply to me</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid job or helping in family business</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organized Sport (eg. practices, matches, competitions etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra-curricular activities (eg. clubs, drama groups, debating, music lessons, church groups etc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homework / Study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socializing (include phone calls, email, SMS text messages)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32. We have been asking you a number of questions about your sleep, mood & activities over the last 2 weeks of the holidays. Was there anything unusual happening over that time that might have affected your answers?

- [ ] No, nothing unusual, the last 2 weeks were pretty typical for me at this time of year
- [ ] Yes (please describe)

_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________
_____________________________________________________

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33. We would welcome any other comments you might have about sleep and sleep difficulties, and how you think this affects you. Please write your comments here.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

Thank you very much for your participation
Term 3
Sleep Habits Survey
2003

ID Number:________________
Term 3
Sleep Habits Survey 2003

This survey is similar to the one you filled out earlier in the year about your holiday sleep habits. We are now interested in your sleep habits during the school term. All your answers are very important to us - please complete every question by putting a circle around the item that best describes your situation.

First, some general details about you.

1. Your age: ____________________

2. □ Female (circle or tick the box to indicate your answer)
   □ Male

3. Are your marks in school mostly

   1 A's  5 C's
   2 A's & B's  6 C's & D's
   3 B's  7 D's
   4 B's & C's  8 D's & E's

4. What do you think is the ideal amount of sleep for you?

   ____________ hours per night
Thinking back over the past two weeks of this term, please fill out the sleep diary as accurately as you can. If you know you went to bed at very different times, for eg. 1 am for one Monday night, and 11 pm the next Monday, average it out to about midnight. If you are unsure, just give your best guess, but please fill in every box. Work your way DOWN each column

<table>
<thead>
<tr>
<th></th>
<th>Sunday Nights</th>
<th>Monday Nights</th>
<th>Tuesday Nights</th>
<th>Wednesday Nights</th>
<th>Thursday Nights</th>
<th>Friday Nights</th>
<th>Saturday Nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. About what time did you <strong>go to bed</strong>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>___ Mins.</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
</tr>
<tr>
<td>6. About how long did it take you to <strong>fall asleep</strong>?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
<td>___ Mins</td>
</tr>
<tr>
<td>7. About what time did you <strong>wake up the next day</strong>?</td>
<td><strong>Monday Wake up</strong></td>
<td><strong>Tuesday Wake up</strong></td>
<td><strong>Wednesday Wake up</strong></td>
<td><strong>Thursday Wake up</strong></td>
<td><strong>Friday Wake up</strong></td>
<td><strong>Saturday Wake up</strong></td>
<td><strong>Sunday Wake up</strong></td>
</tr>
</tbody>
</table>
8. Generally, how long did it take you to fall asleep?
   5  As soon as my head hit the pillow
   4  Less than 30 minutes
   3  Between 30 minutes to 1 hour
   2  Between 1 to 3 hours
   1  More than 3 hours, or I didn’t sleep

9. Some people wake up during the night. Others never do. How many times did you usually wake up at night?
   5  Never
   4  Once
   3  2 or 3 times
   2  More than 3 times
   1  I have no idea

10. Over the last 2 weeks, did you find that you woke in the early hours of the morning and could not get back to sleep?
   5  Never
   4  Once
   3  2 or 3 times
   2  Often
   1  Everyday / night

11. In general, over the last 2 weeks did you feel you usually got ...
   2  Too much sleep?
   3  Enough sleep?
   1  Not enough sleep?

12. Did you consider your overall sleep quality to be ...
    3  Good
    2  Average
    1  Poor
13. Over the last 2 weeks, how often did you think that you got enough sleep?

5 Always
4 Usually
3 Sometimes
2 Rarely
1 Never

14. On the days that you didn’t get enough sleep, what was the major reason?

(tick only one that best describes your situation)

☐ This did not apply to me - I got enough sleep
☐ I had to get up earlier than I wanted
   (please state why eg. school, extra curricular activities, sport, family demands, job etc.)

☐ I stayed up too late
   (please state why eg. socializing, job, T.V., homework / study etc.)

☐ I slept badly

We are interested in the reasons why you think you might have experienced difficulties going to sleep or staying asleep over the past 2 weeks. If you never had trouble sleeping you can tick “does not apply to me” – but please, answer every question.

15. If you had trouble falling asleep over the last 2 weeks what do you think was the main reason for this?

☐ This does not apply to me, generally I had no trouble falling asleep
☐ I wasn’t tired
☐ I was bothered by noise or light
☐ I was too hot / cold / uncomfortable
☐ I wasn’t well
☐ I needed to use the bathroom
☐ I was worried / concerned about personal problems
☐ I was worried / concerned about school
☐ Any other reasons?

__________________________________________

__________________________________________
16. If waking up in the night bothered you over the last 2 weeks, what do you think was the main reason for this?

☐ This does not apply to me, generally I did not wake up in the night
☐ I wasn’t tired
☐ I was bothered by noise or light
☐ I was too hot / cold / uncomfortable
☐ I wasn’t well
☐ I needed to use the bathroom
☐ I was worried / concerned about personal problems
☐ I was worried / concerned about school
☐ Any other reasons?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

17. If you were bothered by waking up in the early hours of the morning and not being able to get back to sleep, what do you think was the main reason for this?

(Don’t include having to wake up early for school, sport, practices etc.)

☐ This does not apply to me, generally I did not wake in the early hours of the morning
☐ I wasn’t tired
☐ I was bothered by noise or light
☐ I was too hot / cold / uncomfortable
☐ I wasn’t well
☐ I needed to use the bathroom
☐ I was worried / concerned about personal problems
☐ I was worried / concerned about school
☐ Any other reasons?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
**18. Over the last 2 weeks, how often did you...**

*(Tick one answer for every item)*

<table>
<thead>
<tr>
<th></th>
<th>Everyday/night</th>
<th>Several times</th>
<th>Once or twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Feel satisfied with your sleep?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B  Have difficulty waking up?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C  Feel sleepy during the day?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D  Doze off or have a nap when you really didn’t want to?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E  Have difficulty keeping your thoughts focused?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F  Have difficulty remembering things?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G  Have difficulty thinking clearly and making decisions?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H  Have others tell you that you look tired and fatigued?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I  Feel in a bad mood because of lack of sleep?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>J  Feel irritated with people even when they were polite?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K  Have difficulty controlling your emotions?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L  Have no energy because of lack of sleep?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M  Feel you were only able to do enough to get by?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N  Have difficulty getting along with others?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O  Feel physically clumsy?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**19. During the last two weeks, how often did you...**

*(Mark one answer for every item)*

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Once or twice</th>
<th>Several times</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Use tobacco (cigarettes, cigars)?</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B  Drink coffee or tea with caffeine?</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C  Drink soft drink / energy drink with caffeine (Coke, Pepsi, Red Bull, Lift +, V, Red Eye, Red Dragon, etc.)?</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D  Drink alcohol (beer, cider, wine, spirits)?</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E  Use medication to help you sleep? (prescribed or over the counter)</td>
<td>1 2 3 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
This section is about your moods and feelings over the past 2 weeks

<table>
<thead>
<tr>
<th></th>
<th>20. How true were each of the following statements for you over the last 2 weeks? (circle one answer for every item)</th>
<th>True</th>
<th>Sometimes True</th>
<th>Not True</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I felt miserable or unhappy</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>I felt I had a number of good qualities</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>I didn’t enjoy anything at all</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>I felt so tired I just sat around and did nothing</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>I was very restless (couldn’t sit still or quiet)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>I felt I was no good any more</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>G</td>
<td>I was able to do things as well as most people</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>I cried a lot</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>I found it hard to think properly or concentrate</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>J</td>
<td>I hated myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>K</td>
<td>I was a bad person</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>L</td>
<td>I took a positive attitude toward myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>M</td>
<td>I felt lonely</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N</td>
<td>I thought nobody really loved me</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>O</td>
<td>I thought I could never be as good as other people</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>I did everything wrong</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Q</td>
<td>I generally felt satisfied with myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
In this section we are interested in how you might organize the timing of various activities if you were free to plan your day according to when you feel your best. Please answer the questions based on your body’s “feeling best” times.

21. Imagine school is cancelled. You can get up whenever you want to. When would you get out of bed? Between...

5. 5.00 - 6.30 am.
4. 6.30 - 7.45 am
3. 7.45 - 9.45 am
2. 9.45 - 11.00 am
1. 11.00 - Noon

22. Is it easy for you to get up in the morning?

1. No
2. Sort of
3. Pretty easy
4. Easy

23. Sports practice is set for 7.00 in the morning. How do you think you'll do?

4. My best
3. Okay
2. Worse than usual
1. Awful

24. The bad news: You have to take a two hour exam. The good news: You can take it when you think you'll do your best. What time is that?

4. 8.00am - 10.00 am
3. 11.00am - 1.00 pm
2. 3.00 pm - 5.00 pm
1. 7.00 pm - 9.00 pm

25. When do you have the most energy to do your favourite things?

4. Morning. I am tired in the evening
3. Morning more than evening
2. Evening more than morning
1. Evening. I am tired in the morning
26. What time would you prefer to go to bed? Between:

5. 8.00 - 9.00 pm.
4. 9.00 - 10.15 pm.
3. 10.15 pm. - 12.30 am.
2. 12.30 - 1.45 am.
1. 1.45 - 3.00 am.

27. How alert are you in the first half hour you're up?

1. Out of it
2. A little dazed
3. Okay
4. Ready to take on the world

28. When does your body start to tell you it's time for bed even if you ignore it? Between...

5. 8.00 - 9.00 pm.
4. 9.00 - 10.15 pm.
3. 10.15 pm. - 12.30 am.
2. 12.30 - 1.45 am.
1. 1.45 - 3.00 am.

29. If you had to get up at 6.00 am. every morning: What would it be like for you?

1. Awful
2. Not so great
3. Okay (if I have to)
4. Fine, no problem

30. When you wake up in the morning how long does it take for you to be totally “with it”?

4. 0 - 10 minutes
3. 11 - 20 minutes
2. 21 - 40 minutes
1. More than 40 minutes
In this section, we’d like to get an idea about how busy you were with scheduled activities during the past two weeks of this term.

### My Activities during Term 3

31. Thinking back over the last 2 weeks, fill out how many hours you generally spent doing the following activities...

<table>
<thead>
<tr>
<th>Activity</th>
<th>About how many hours per week</th>
<th>Does not apply to me</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid job or helping in family business</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organized Sport (eg. practices, matches, competitions etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra-curricular activities (eg. clubs, drama groups, debating, music lessons, church groups etc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homework / Study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socializing (include phone calls, email, SMS text messages)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32. We have been asking you a number of questions about your sleep, mood & activities over the last 2 weeks. Was there anything unusual happening over that time that might have affected your answers?

2. No, nothing unusual, the last 2 weeks were pretty typical for me at this time of year

1. Yes (please describe)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
33. We would welcome any other comments you might have about sleep and sleep difficulties, and how you think this affects you. Please write your comments here.

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________

_____________________________________________________________________


Thank you very much for your participation
Appendix B

School Sleep Habits Survey
School Sleep Habits Survey
(available www.sleepforscience.org.au)

Developed in 1994 by the Bradley Hospital/Brown University Sleep Research Lab, the School Sleep Habits Survey was administered to over 3,000 high school students in Rhode island. Results using this instrument are reported in Wolfson R & Carskadon MA (1998). Sleep schedules and daytime functioning in adolescents. Child Development, 69, 875-887.

The following scales were created from survey items:

**Depressed Mood Scale**


Each of the 6 items in Question # 46 is coded as 1 = not at all, 2 = somewhat, 3 = much. Item scores are summed to obtain a total scale score.

**Sleepiness Scale**

Each of 10 items in Question #43 is coded as 1 = no, 2 = struggled to stay awake, 3 = fallen asleep, 4 = both struggled to stay awake and fallen asleep. Item scores are summed to obtain a total scale score.

**Sleep/Wake Problems Behaviour Scale**

Each of 15 items in Question # 45 is coded as 5 = everyday/night, 4 = several times, 3 = twice, 2 = once, 1 = never. Scores from 10 of the items are added to obtain a total scale score: b,c,d,f,g,h,l,j,k,m.

**The Superscience Morningness/Eveningness Scale**

This scale is derived from responses to Questions 47 through 56. Response items for Questions 47,52, and 54 are coded from 5 to 1 with the first response coded as 5 and the last response item coded as 1.

Response items for Questions 48, 53, and 55 are coded from 1 to 4 with the first response item coded as 1 and the last response item coded as 4.

Response items for Questions 49, 50, 51, and 56 are coded from 4 to 1 with the first response item coded as 4 and the last response item coded as 1.

Item scores are summed to obtain a total scale score.
# School Sleep Habits Survey

## INSTRUCTIONS

Please answer the questions on the following pages as accurately and honestly as you can. There are no right or wrong answers.

- When you mark a response, please be sure to mark it neatly.
- Darken the bubbles as completely as possible using a pencil.
- Avoid stray marks and treat forms gently.
- Do not spend too much time on any one answer. Your first impression is usually best.
- Answer each question in the order that it appears. Do not go back and check your answers.
- Place an X beside any item that YOU DO NOT UNDERSTAND or that DOES NOT APPLY TO YOU or for which you CANNOT GIVE A TRUTHFUL ANSWER.
- Be sure to complete BOTH SIDES of every page.

## 1. Today's Date:

<table>
<thead>
<tr>
<th>Month</th>
<th>Day</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td></td>
<td></td>
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<tr>
<td>Mar</td>
<td></td>
<td></td>
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<tr>
<td>Apr</td>
<td></td>
<td></td>
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<tr>
<td>May</td>
<td></td>
<td></td>
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<td>Jun</td>
<td></td>
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<tr>
<td>Jul</td>
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<td>Aug</td>
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<td></td>
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<td>Sept</td>
<td></td>
<td></td>
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<tr>
<td>Oct</td>
<td></td>
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<tr>
<td>Nov</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 2. Birth Date:

<table>
<thead>
<tr>
<th>Month</th>
<th>Day</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
<td></td>
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<tr>
<td>Feb</td>
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<td>Mar</td>
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<td>May</td>
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<td>Jun</td>
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<td>Jul</td>
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<td>Aug</td>
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<td>Sept</td>
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<tr>
<td>Oct</td>
<td></td>
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<tr>
<td>Nov</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 7. What is your age in years?

- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12
- [ ] 13
- [ ] 14
- [ ] 15
- [ ] 16
- [ ] 17
- [ ] 18
- [ ] 19

## 8. What grade are you in?

- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12

## FOR OFFICE USE ONLY

- [ ] 00381

- [ ] DO NOT WRITE IN THIS AREA
9. What best describes your racial/ethnic background?
   - White/Caucasian
   - Black/African American
   - Hispanic/Latino
   - Asian/Asian American
   - Native American/Amerindian
   - Multiracial (please specify)
   - Other (please specify)

10. In the last two weeks, have you slept in the same bed?
   - Every night
   - Almost every night
   - A few nights
   - Not at all

11. Who lives in your home other than you? Please indicate yes or no for every category below:

   - Mother/step-mother
   - Father/step-father
   - Older brother(s)/sister(s)
   - Younger brother(s)/sister(s)
   - Other family member(s)

12. Does your mother work outside of the home?
   - Yes
   - No
   
   If yes, mark each label that best describes her work:
   - Day shift
   - Evening shift
   - Night shift (graveyard)
   - Changing shifts

13. Does your father work outside of the home?
   - Yes
   - No
   
   If yes, mark each label that best describes his work:
   - Day shift
   - Evening shift
   - Night shift (graveyard)
   - Changing shifts

14. Are your grades in school mostly?
   - A's
   - A's and B's
   - B's
   - B's and C's

15. What is the highest grade in school you expect to complete? (mark one)
   - May not finish high school
   - Will finish high school
   - Will get a college degree
   - Will get a degree beyond college

16. Do you have any disabilities or chronic illnesses (for example, asthma, diabetes, deafness, loss of the use of a limb, etc.)?
   - Yes
   - No
   
   If yes, please specify:

17. Compared to other people your age, would you say that your health is:
   - Poor
   - Fair
   - Good
   - Excellent

18. Do you have attention deficit hyperactivity disorder (ADHD) or a learning disability?
   - Yes
   - No

19. Do you take Ritalin or some other medication to help with concentration or a learning problem?
   - Yes
   - No

20. Do you have an individualized education program or receive special help for difficulties with school work?
   - Yes
   - No

21. During the last two weeks, how many days did you stay home from school because you were:
   - a. sick?
   - b. other?
   
   Why did you stay home from school?
9. What best describes your racial/ethnic background?
- White/Caucasian
- Black/African American
- Hispanic/Latino
- Asian/Asian American
- Native American/Amerindian
- Multiracial (please specify)
- Other (please specify)

10. In the last two weeks, have you slept in the same bed?
- Every night
- Almost every night
- A few nights
- Not at all

11. Who lives in your home other than you? Please indicate yes or no for every category below:
- Mother/step-mother
- Father/step-father
- Older brother(s)/sister(s)
- Younger brother(s)/sister(s)
- Other family member(s)

Yes
No

12. Does your mother work outside of the home?
- Yes
- No

If yes, mark each label that best describes her work:
- Day shift
- Evening shift
- Night shift (graveyard)
- Changing shifts
- Full time
- Part time
- One job
- More than one job

13. Does your father work outside of the home?
- Yes
- No

If yes, mark each label that best describes his work:
- Day shift
- Evening shift
- Night shift (graveyard)
- Changing shifts
- Full time
- Part time
- One job
- More than one job

14. Are your grades in school mostly?
- A's
- A's and B's
- B's
- B's and C's
- C's
- C's and D's
- D's
- D's and F's

15. What is the highest grade in school you expect to complete? (Mark one)
- May not finish high school
- Will finish high school
- Will get a college degree
- Will get a degree beyond college

16. Do you have any disabilities or chronic illnesses (for example, asthma, diabetes, deafness, loss of the use of a limb, etc.)?
- Yes
- No

If yes, please specify:

17. Compared to other people your age, would you say that your health is:
- Poor
- Fair
- Good
- Excellent

18. Do you have attention deficit hyperactivity disorder (ADHD) or a learning disability?
- Yes
- No

19. Do you take Ritalin or some other medication to help with concentration or a learning problem?
- Yes
- No

20. Do you have an individualized education program or receive special help for difficulties with school work?
- Yes
- No

21. During the last two weeks, how many days did you stay home from school because you were:
- a. sick? 0 1 2 3 4 5 6 7 8 9 10
- b. other? 0 1 2 3 4 5 6 7 8 9 10

Why did you stay home from school?
There are no right or wrong answers. Be careful to choose the one answer that best describes the way your sleep has been in the last two school weeks (unless otherwise instructed).

The next set of questions has to do with your usual schedule on days when you have school.

22. What time do you usually go to bed on school days?
   List ONE time, not a range.
   ________________
   O A.M.          O P.M.

23. There are many reasons for doing things at one time or another. What is the main reason you usually go to bed at this time on school days? (mark one)
   O My parents have set my bedtime
   O I feel sleepy
   O I finish my homework
   O My TV shows are over
   O My brother(s) or sister(s) go to bed
   O I finish socializing
   O I get home from my job
   O Other: ________________

24. What time do you usually wake up on school days?
   ________________
   O A.M.          O P.M.

25. What is the main reason you usually wake up at this time on school days? (choose one)
   O Noises or my pet wakes me up
   O My alarm clock wakes me up
   O My parents or other family members wake me up
   O I need to go to the bathroom
   O I don't know, I just wake up
   O Other: ________________

26. What time do you usually leave home on school days?
   ________________
   O A.M.          O P.M.

27. How do you usually get to school?
   O Walk
   O Get a ride with friend(s)
   O Take the bus
   O Drive my car
   O Get a ride with parent

28. Figure out how long you usually sleep on a normal school night and fill it in here. [Do not include time you spend awake in bed. Remember to mark hours and minutes, even if minutes are zero.]
   ___ hours ___ minutes
32. What time do you **usually** wake up on weekends?

```
A.M.  P.M.
```

33. What is the **main reason** you usually wake up at this time on weekends? (choose one)

- My alarm clock wakes me up
- My parents wake me up
- I need to go to the bathroom
- I don’t know, I just wake up
- Other: _______________

34. Figure out how long you usually sleep on a night when you do not have school the next day (such as a weekend night) and fill it in here. [Do not include time you spend awake in bed. Remember to mark hours and minutes, even if minutes are zero.]

```
__________ hours  __________ minutes
```

35. On weekends, after you go to bed at night, about how long does it usually take you to fall asleep?

```
__________ minutes
```

36. Some people wake up during the night. Others never do. How many times do you **usually** wake up at night?

- Never
- Once
- 2 or 3 times
- More than 3 times
- I have no idea

37. People sometimes feel sleepy during the daytime. During your daytime activities, how much of a problem do you have with sleepiness (feeling sleepy, struggling to stay awake)?

- No problem at all
- A little problem
- More than a little problem
- A big problem
- A very big problem

38. Some people take naps in the daytime every day, others never do. When do you nap? (mark all that apply.)

- I never nap.
- I sometimes nap on school days.
- I sometimes nap on weekends.
- I never nap unless I am sick.

39. Can you figure out how much sleep you need? Fill out below how much sleep you think you would need each night to feel your best every day. [Remember to mark hours and minutes, even if minutes are zero.]

```
__________ hours  __________ minutes
```

40. In general, do you feel you usually get:

- too much sleep?
- enough sleep?
- too little sleep?

41. Do you consider yourself to be:

- a good sleeper?
- a poor sleeper?

42. How often do you think that you get enough sleep?

- Always
- Usually
- Sometimes
- Rarely
- Never

---

**FOR OFFICE USE ONLY**

<table>
<thead>
<tr>
<th>32 Hour Min.</th>
<th>34 Hour Min.</th>
<th>35 Minutes</th>
<th>39 Hour Min.</th>
<th>ID Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 4 -
Questions 43 to 46 are about things that have happened in the last two weeks.

43. During the last two weeks, have you struggled to stay awake (fought sleep) or fallen asleep in the following situations? (Mark one answer for every item.)

<table>
<thead>
<tr>
<th>Both struggled to stay awake and fallen asleep</th>
<th>Struggled to stay awake No</th>
</tr>
</thead>
<tbody>
<tr>
<td>• in a face-to-face conversation with another person? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• traveling in a bus, train, plane or car? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• attending a performance (movie, concert, play)? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• watching television or listening to the radio or stereo? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• reading, studying or doing homework? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• during a test? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• in a class at school? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• while doing work on a computer or typewriter? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• playing video games? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>• driving a car? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
</tr>
</tbody>
</table>

Do you drive?  ○ Yes  ○ No

44. During the last two weeks, how often did you . . .
(Mark one answer for every item.)

<table>
<thead>
<tr>
<th>Everyday</th>
<th>Several times every day</th>
<th>Once or twice a day</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. drink soda with caffeine [like Coke, Pepsi; not like root beer, orange soda or Sprite]? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. drink coffee or tea with caffeine? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. use tobacco? [cigarettes, cigar, chewing tobacco, etc.] ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. drink alcohol [beer, wine, liquor]? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. use drugs [like marijuana, cocaine]? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

please specify type:

45. In the last two weeks, how often have you . . . (Mark one answer for every item.)

<table>
<thead>
<tr>
<th>Never</th>
<th>Once</th>
<th>Twice</th>
<th>Several times</th>
<th>Everyday/night</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. felt satisfied with your sleep? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. arrived late to class because you overslept? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. fallen asleep in a morning class? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. fallen asleep in an afternoon class? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. awakened too early in the morning and couldn't get back to sleep? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. stayed up until at least 3 a.m.? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. stayed up all night? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. slept in past noon? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. felt tired, dragged out, or sleepy during the day? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. needed more than one reminder to get up in the morning? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. had an extremely hard time falling asleep? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l. had nightmares or bad dreams during the night? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m. gone to bed because you just could not stay awake any longer? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n. done dangerous things without thinking? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o. had a good night’s sleep? ..................................................</td>
<td>○ ○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

46. During the last two weeks, how often were you bothered or trouble by the following?

<table>
<thead>
<tr>
<th>Much</th>
<th>Somewhat</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Feeling too tired to do things ..................................................</td>
<td>○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>b. Having trouble going to sleep or staying asleep ..................................................</td>
<td>○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>c. Feeling unhappy, sad, or depressed ..................................................</td>
<td>○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>d. Feeling hopeless about the future ..................................................</td>
<td>○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>e. Feeling nervous or tense ..................................................</td>
<td>○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>f. Worrying too much about things ..................................................</td>
<td>○ ○ ○</td>
<td></td>
</tr>
</tbody>
</table>
Questions 47 - 56 have to do with how you might organize the timing of various activities if you were free to plan your day according to when you feel your best. Please answer the questions based on your body’s “feeling best” times.

47. Imagine: School is cancelled! You can get up whenever you want to. When would you get out of bed? Between:
   - 5:00 and 6:30 a.m.
   - 6:30 and 7:45 a.m.
   - 7:45 and 9:45 a.m.
   - 9:45 and 11:00 a.m.
   - 11:00 a.m. and noon

48. Is it easy for you to get up in the morning?
   - No way!
   - Sort of.
   - Pretty easy.
   - It's a cinch!

49. Gym class is set for 7:00 in the morning. How do you think you’d do?
   - My best!
   - Okay.
   - Worse than usual.
   - Awful!

50. The bad news: You have to take a two-hour test. The good news: You can take it when you think you’ll do your best. What time is that?
   - 8:00 to 10:00 a.m.
   - 11:00 a.m. to 1:00 p.m.
   - 3:00 p.m. to 5:00 p.m.
   - 7:00 p.m. to 9:00 p.m.

51. When do you have the most energy to do your favorite things?
   - Morning! I am tired in the evening.
   - Morning more than evening.
   - Evening more than morning.
   - Evening! I am tired in the morning.

52. Your parents have decided to let you set your own bed time. What time would you pick? Between:
   - 8:00 and 9:00 p.m.
   - 9:00 and 10:15 p.m.
   - 10:15 p.m. and 11:30 p.m.
   - 12:30 and 1:45 a.m.
   - 1:45 and 3:00 a.m.

53. How alert are you in the first half hour you’re up?
   - Out of it.
   - A little dazed.
   - Okay.
   - Ready to take on the world.

54. When does your body start to tell you it’s time for bed (even if you ignore it)? Between:
   - 8:00 and 9:00 p.m.
   - 9:00 and 10:15 p.m.
   - 10:15 p.m. and 12:30 a.m.
   - 12:30 and 1:45 a.m.
   - 1:45 and 3:00 a.m.

55. Say you had to get up at 6:00 a.m. every morning: What would it be like?
   - Awful!
   - Not so great.
   - Okay (if I have to).
   - Fine, no problem!

56. When you wake up in the morning how long does it take for you to be totally “with it”?
   - 0 to 10 minutes
   - 11 to 20 minutes
   - 21 to 40 minutes
   - More than 40 minutes

57. Would you say that your growth in height:
   - Has not begun to spurt ("spurt" means faster growth than usual)
   - Has barely started
   - Is definitely underway
   - Seems complete
   - I don’t know

58. Would you say that your other signs of physical maturation:
   - Have not yet started to show
   - Have barely started to show
   - Are definitely underway
   - Seem complete
   - I don’t know

[Diagram with grid and numbers]

DO NOT WRITE IN THIS AREA

- 6 -
59. During the last week, did you work at a job for pay?  
(If no, skip to number 60.)
  ○ Yes  ○ No

What kind of job?

How many days did you work at the following times?  
in the morning before school ......................................................... 0 1 2 3 4 5  in the afternoon after school ......................................................... 0 1 2 3 4 5  in the evening on days that you have school ......................................................... 0 1 2 3 4 5  on the weekend ......................................................... 0 1 2

How many hours did you work at your paying job this week?  
during the school week: ________ hours  
during the weekend: ________ hours

During the last two weeks, have you struggled to stay awake (tough sleep) or fallen asleep at your job?  
  ○ no  ○ struggled to stay awake  
  ○ fallen asleep  ○ both struggled to stay awake and fallen asleep

If you did not have your job, would you go to bed:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

If you did not have your job, would you wake up:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

60. During the last week, did you engage in organized sports or a regularly scheduled physical activity?  
(If no, skip to number 61.)
  ○ Yes  ○ No

What kind of sport?

How many days did you practice at the following times?  
in the morning before school ......................................................... 0 1 2 3 4 5  in the afternoon after school ......................................................... 0 1 2 3 4 5  in the evening on days that you have school ......................................................... 0 1 2 3 4 5  on the weekend ......................................................... 0 1 2

How many hours did you practice this week?  
during the school week: ________ hours  
during the weekend: ________ hours

During the last two weeks, have you struggled to stay awake (tough sleep) or fallen asleep during practice?  
  ○ no  ○ struggled to stay awake  
  ○ fallen asleep  ○ both struggled to stay awake and fallen asleep

If you did not have your sports activity, would you go to bed:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

If you did not have your sports activity, would you wake up:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

61. During the last week, did you participate in organized extracurricular activities?  
(For example, committees, clubs, volunteer work, musical groups, church groups, etc.)  
(If no, skip to number 62.)
  ○ Yes  ○ No

What kind of activity?

How many days did you participate at the following times?  
in the morning before school ......................................................... 0 1 2 3 4 5  in the afternoon after school ......................................................... 0 1 2 3 4 5  in the evening on days that you have school ......................................................... 0 1 2 3 4 5  on the weekend ......................................................... 0 1 2

How many hours did you participate this week?  
during the school week: ________ hours  
during the weekend: ________ hours

During the last two weeks, have you struggled to stay awake (tough sleep) or fallen asleep during this participation?  
  ○ no  ○ struggled to stay awake  
  ○ fallen asleep  ○ both struggled to stay awake and fallen asleep

If you did not have your organized activity, would you go to bed:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

If you did not have your organized activity, would you wake up:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

62. During the last week, did you study/do homework?  
  ○ Yes  ○ No (If no, skip to number 63.)

How many days did you study at the following times?  
in the morning before school ......................................................... 0 1 2 3 4 5  in the afternoon after school ......................................................... 0 1 2 3 4 5  in the evening on days that you have school ......................................................... 0 1 2 3 4 5  on the weekend ......................................................... 0 1 2

How many hours did you study this week?  
during the school week: ________ hours  
during the weekend: ________ hours

During the last two weeks, have you struggled to stay awake (tough sleep) or fallen asleep during studying?  
  ○ no  ○ struggled to stay awake  
  ○ fallen asleep  ○ both struggled to stay awake and fallen asleep

If you did not have your homework, would you go to bed:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.

If you did not have your homework, would you wake up:  
  ○ earlier than you do.  ○ the same as you do.  
  ○ later than you do.
Appendix C

Pittsburgh Insomnia Rating Scale
# Pittsburgh Insomnia Rating Scale

(University of Pittsburgh School of Medicine. Department of Psychiatry. All Rights Reserved)

Name__________________________ ID#____________________ Date____________________

A. Overall sleep quality: Consider the quality of your sleep in the past 7 days. Then mark that point along the line that best describes your sleep quality in the past 7 days:

Horrible __________________________ Wonderful __________________________

The following questions ask about your sleep in the past 7 days and nights. Please circle the one best answer for each question.

<table>
<thead>
<tr>
<th>B. In the past week, how much were you bothered by:</th>
<th>Not at all bothered</th>
<th>Slightly bothered</th>
<th>Moderately bothered</th>
<th>Severely bothered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Difficulty getting to sleep at bedtime</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. One or more awakenings after getting to sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Waking up too early in the morning</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Not getting enough sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Different sleep patterns from one night to the next</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Sleep occurring at odd times or not at all</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Intense or disturbing dreams</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. Sensations (like noises, hot or cold, pain) during the night</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Physical tension at night</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10. Moving too much in bed</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11. Anxiety or worries about getting to sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12. Anxiety or worries about lack of sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13. Anxiety or worries about what might happen</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>14. General nervousness and stress</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15. Poor sleeping causing you to feel tired</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>16. Stress causing poor sleeping</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>17. Your mind not slowing down at bedtime</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

(UNIVERSITY OF PITTSBURGH)
<table>
<thead>
<tr>
<th>In the past week, how much were you bothered by:</th>
<th>Not at all bothered</th>
<th>Slightly bothered</th>
<th>Moderately bothered</th>
<th>Severely bothered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. Loss of desire for physical intimacy or sex</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>19. Sleep that doesn’t fully refresh you</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>20. Difficulty waking up</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>21. Poor alertness during the daytime</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>22. Difficulty keeping your thoughts focused</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>23. Your mind never slowing down during the daytime</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>24. Difficulty remembering things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>25. Difficulty thinking clearly and making decisions</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>26. Tiredness or fatigue</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>27. Dazing off or napping when you really didn’t want to</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>28. Others noticing you appeared tired or fatigued</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>29. Too many difficulties to overcome</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>30. Being unsure about handling your personal problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>31. Being unsure about dealing with day-to-day problems</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>32. Irritation with sounds, sights, or sensations during the day</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>33. Bad mood(s) because you had poor sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>34. Irritation with people even when they were polite</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>35. Difficulty controlling your emotions</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>36. Needing to keep quiet around other people</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>37. Lack of energy because of poor sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>38. Poor sleep that interferes with your relationships</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>39. Feeling sleepy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>40. Being unable to sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>41. Feeling that time itself slowed down</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>42. Being able to do only enough to get by</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>43. Difficulty getting along with other people</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>44. Physical clumsiness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>45. Feeling physically ill or prone to infection</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>46. Being forced to pay special attention to what you eat or what you do so that you can sleep better</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
C. Please circle the best answer for each question about the past week:

47. From the time you tried to go to sleep, how long did it take to fall asleep on the \textit{worst} night?
   0. Less than 1/2 hour
   1. Between 1/2 to 1 hour
   2. Between 1 to 3 hours
   3. More than 3 hours or I didn’t sleep.

48. From the time you tried to go to sleep, how long did it take to fall asleep on \textit{most} nights?
   0. Less than 1/2 hour
   1. Between 1/2 to 1 hour
   2. Between 1 to 3 hours
   3. More than 3 hours or I didn’t sleep.

49. If you woke up during the night, how long did it take to fall back to sleep on the \textit{worst} night?
   0. Less than 1/2 hour or I didn’t wake up
   1. Between 1/2 to 1 hour
   2. Between 1 to 3 hours
   3. More than 3 hours or I didn’t fall back to sleep.

50. If you woke up during the night, how long did it take to fall back to sleep on \textit{most} nights?
   0. Less than 1/2 hour or I didn’t wake up
   1. Between 1/2 to 1 hour
   2. Between 1 to 3 hours
   3. More than 3 hours or I didn’t fall back to sleep.

51. Not counting times when you were awake in bed, how many hours of \textit{actual} sleep did you get during the \textit{worst} night?
   0. More than 7 hours
   1. Between 4 to 7 hours
   2. Between 2 to 4 hours
   3. Less than 2 hours or I didn’t sleep.

52. Not counting times when you were awake in bed, how many hours of \textit{actual} sleep did you get during \textit{most} nights?
   0. More than 7 hours
   1. Between 4 to 7 hours
   2. Between 2 to 4 hours
   3. Less than 2 hours or I didn’t sleep.
53. On how many nights did it take longer than 30 minutes to fall to sleep?  
   0  None or 1 night  
   1  On 2 or 3 nights  
   2  On 4 or 5 nights  
   3  On 6 or all nights  

54. On how many nights did you wake up and have trouble falling back to sleep?  
   0  None or 1 night  
   1  On 2 or 3 nights  
   2  On 4 or 5 nights  
   3  On 6 or all nights  

55. On how many mornings did you wake up not fully rested?  
   0  None or 1 morning  
   1  On 2 or 3 mornings  
   2  On 4 or 5 mornings  
   3  On 6 or all mornings  

56. On how many days did you have trouble coping because of poor sleep?  
   0  None or 1 day  
   1  On 2 or 3 days  
   2  On 4 or 5 days  
   3  On 6 or all days  

---

D. Over the past week, how would you rate:  

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>57. Your sleep quality, compared to most people</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>58. Your satisfaction with your sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>59. Your ability to get things done, compared to your best</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>60. Your satisfaction with how you get things done</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>61. The regularity of your sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>62. The soundness of your sleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>63. How well you talked and communicated with others</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>64. Your sense of humor</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>65. Your quality of life</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
E. Thank you for completing this rating scale
   We Welcome Your Comments

66. Please feel free to tell us about any aspects of your sleep or wakefulness we may have missed. Also, feel free to tell us your opinion about this insomnia rating scale.

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________

__________________________________________

Appendix D

Sleep Quality Scale
Sleep Quality Scale.

This six-item scale was developed for the present study and consists of questions 8 – 13 on both the T1 (Holiday) and T2 (School Term) surveys. Coding of participant responses to each of the items is shown. Notes about each of the questions are included in italics, providing information about how the items were adapted or taken from other instruments.

Now, thinking generally about the quality of your sleep over the last 2 weeks of the holidays/ (the school term)

8. Generally, how long did it take you to fall asleep?

5. As soon as my head hit the pillow
4. Less than 30 minutes
3. Between 30 minutes to 1 hour
2. Between 1 to 3 hours
1. More than 3 hours, or I didn’t sleep

*Note: This item was adapted from Question 48 on the Pittsburgh Insomnia Rating Scale (PIRS) (Moul et al., 2002), which is displayed in Appendix C. “From the time you tried to go to sleep, how long did it take to fall asleep on most nights” was changed to “generally, how long did it take you to fall asleep?” for the present study, in order to improve clarity for the adolescent sample.*

9. Some people wake up during the night. Others never do. How many times did you usually wake up at night?

5. Never
4. Once
3. 2 or 3 times
2. More than 3 times
1. I have no idea

*Note: This item was taken from Question 36 on the School Sleep Habits Survey (Wolfson & Carskadon, 1998) which is displayed in Appendix B. Before computing scale scores this item was recoded so that the last option (“I have no idea”) was recoded as missing data, in order to reflect that the participant was not able to estimate how many times they woke at night (see section 9.2.3)*

10. Over the last 2 weeks, did you find that you woke in the early hours of the morning and could not get back to sleep?

5. Never
4. Once
3. 2 or 3 times
2. Often
1. Everyday / night

Note: This question was adapted from Question 45 (e) on the School Sleep Habits Survey (see Appendix B). “Awakened” was changed to “woke” in order to reflect Australian adolescent word usage.

11. In general, over the last 2 weeks did you feel you usually got ...

   2. Too much sleep?
   3. Enough sleep?
   1. Not enough sleep?

Note: This question was adapted from Question 40 on the School Sleep Habits Survey (see Appendix B). “Too little sleep” was changed to “not enough sleep” in keeping with the informal tone of the survey.
The first option (“too much sleep”) was recoded as “0” before totaling scale scores. This was the same value given to “not enough sleep”. Both of these options reflect a negative evaluation of the amount of sleep obtained for the purpose of overall sleep quality. However, the three options were reported separately in analyses of responses to individual items on the Sleep Quality Scale.

13. Did you consider your overall sleep quality to be ...

   3. Good
   2. Average
   1. Poor

Note: This item was adapted from Question 41 on the School Sleep Habits Survey (see Appendix B). The question was expanded to stress “overall sleep quality” in order to gain a self-rating of this construct. A third response of “average” was also included in the present survey to allow for a more neutral self-rating.

13. Over the last 2 weeks, how often did you think that you got enough sleep?

   5. Always
   4. Usually
   3. Sometimes
   2. Rarely
   1. Never

Note: This question was taken from Question 42 on the School Sleep Habits Survey (see Appendix B). The tense of the question, and the addition of “over the last 2 weeks” were the only changes. This was done to keep reminding the participants of the time frame of interest.
Appendix E

Daytime Functioning Scale
Daytime Functioning Scale

This 15-item scale was developed for the present study and is presented as Question 18 on both the T1 (Holiday) and T2 (School Term) surveys. Coding of participant responses to each of the items is shown. Notes about each of the items are included in italics, providing information about how the items were adapted or taken from other instruments.

18. Over the last 2 weeks of the holidays/school term, how often did you....

(Tick one answer for every item)

<table>
<thead>
<tr>
<th></th>
<th>Everyday/night</th>
<th>Several times</th>
<th>Once or twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Feel satisfied with your sleep?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Have difficulty waking up?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Feel sleepy during the day?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Doze off or have a nap when you really didn’t want to?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Have difficulty keeping your thoughts focused?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Have difficulty remembering things?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Have difficulty thinking clearly and making decisions?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Have others tell you that you look tired and fatigued?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Feel in a bad mood because of lack of sleep?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Feel irritated with people even when they were polite?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Have difficulty controlling your emotions?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Have no energy because of lack of sleep?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Feel you were only able to do enough to get by?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Have difficulty getting along with others?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Feel physically clumsy?</td>
<td>4 3 2 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Item A was taken from Question 45 (a) on the School Sleep Habits Survey (Wolfson & Carskadon, 1998), which is presented in AppendixB. This item is reverse scored.
Items B – O were adapted from Section B of the Pittsburgh Insomnia rating Scale (PIRS) (Moul et al., 2002), which is displayed in Appendix C. For the present study “in the past week” was changed to “over the last 2 weeks” to reflect the time frame of interest for the current project. The possible responses for these items reflected frequency of the behaviour rather than whether the behaviour bothered the participant as in the PIRS. Thus, the possible responses were in keeping with the response sets for Question 45 on the School Sleep Habits Survey (see Appendix B).
Appendix F

Short Moods and Feelings Questionnaire
**Short Moods and Feelings Questionnaire (SMFQ).**

This 13-item scale is presented as Question 20 on both the T1 (Holiday) and T2 (School Term) surveys. Coding of participant responses to each of the items is shown. Notes are included in italics, providing information about the items.

<table>
<thead>
<tr>
<th></th>
<th>20. How true were each of the following statements for you over the last 2 weeks of the holidays/ (school term)? (circle one answer for every item)</th>
<th>True</th>
<th>Sometimes True</th>
<th>Not True</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I felt miserable or unhappy</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>I felt I had a number of good qualities</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>I didn't enjoy anything at all</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>I felt so tired I just sat around and did nothing</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>I was very restless (couldn't sit still or quiet)</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>I felt I was no good any more</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>G</td>
<td>I was able to do things as well as most people</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>H</td>
<td>I cried a lot</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>I</td>
<td>I found it hard to think properly or concentrate</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>J</td>
<td>I hated myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>K</td>
<td>I was a bad person</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>L</td>
<td>I took a positive attitude toward myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>M</td>
<td>I felt lonely</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N</td>
<td>I thought nobody really loved me</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>O</td>
<td>I thought I could never be as good as other people</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>P</td>
<td>I did everything wrong</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Q</td>
<td>I generally felt satisfied with myself</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note: Items B, G, L, and Q were taken from the Self Esteem Scale (Rosenberg, 1965). These items were not scored, but were used to improve participants’ perception of the SMFQ.*

*All other items make up the SMFQ (Angold et al., 1995). Scoring was reversed so that higher scores reflected better mood.*
Appendix G

Superscience Morningness/Eveningness Scale
Superscience Morningness/Eveningness Scale (SMES)

This 10-item scale is presented as Questions 21 to 30 on both the T1 (Holiday) and T2 (School Term) surveys. Coding of participant responses to each of the items is shown. The scale is as presented in the School Sleep Habits Survey (Wolfson & Carskadon, 1998) in Questions 47 to 56 (see Appendix B). Two modifications were made to wording to appeal to the present Australian sample, and these changes are included in notes after the appropriate item.

21. Imagine school is cancelled. You can get up whenever you want to. When would you get out of bed? Between...

<table>
<thead>
<tr>
<th></th>
<th>5.00 - 6.30 am.</th>
<th>6.30 - 7.45 am</th>
<th>7.45 - 9.45 am</th>
<th>9.45 - 11.00 am</th>
<th>11.00 - Noon</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

22. Is it easy for you to get up in the morning?

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Sort of</th>
<th>Pretty easy</th>
<th>Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

23. Sports practice is set for 7.00 in the morning. How do you think you’ll do?

<table>
<thead>
<tr>
<th></th>
<th>My best</th>
<th>Okay</th>
<th>Worse than usual</th>
<th>Awful</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: “sports practice” was substituted for “gym practice”, in order to reflect Australian language use.

24. The bad news: You have to take a two hour exam. The good news: You can take it when you think you’ll do your best. What time is that?

<table>
<thead>
<tr>
<th></th>
<th>8.00am - 10.00 am</th>
<th>11.00am - 1.00 pm</th>
<th>3.00 pm - 5.00 pm</th>
<th>7.00 pm - 9.00 pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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</table>
25. When do you have the most energy to do your favourite things?

4. Morning. I am tired in the evening
3. Morning more than evening
2. Evening more than morning
1. Evening. I am tired in the morning

26. What time would you prefer to go to bed? Between:

5. 8.00 - 9.00 pm.
4. 9.00 - 10.15 pm.
3. 10.15 pm. - 12.30 am.
2. 12.30 - 1.45 am.
1. 1.45 - 3.00 am.

Note: this question was changed from “your parents have decided to let you set your own bed time. What time would you pick?” in order to be more appropriate for the age range of the current sample.

27. How alert are you in the first half hour you’re up?

1. Out of it
2. A little dazed
3. Okay
4. Ready to take on the world

28. When does your body start to tell you it’s time for bed even if you ignore it? Between...

5. 8.00 - 9.00 pm.
4. 9.00 - 10.15 pm.
3. 10.15 pm. - 12.30 am.
2. 12.30 - 1.45 am.
1. 1.45 - 3.00 am.

29. If you had to get up at 6.00 am. every morning: What would it be like for you?

1. Awful
2. Not so great
3. Okay (if I have to)
4. Fine, no problem
30. When you wake up in the morning how long does it take for you to be totally "with it"?

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<thead>
<tr>
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<th>0 - 10 minutes</th>
<th>11 - 20 minutes</th>
<th>21 - 40 minutes</th>
<th>More than 40 minutes</th>
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Appendix H

Perceived Reasons for Insufficient Sleep
Perceived Reasons for Insufficient Sleep

The perceived reasons for not obtaining enough sleep were presented as question 14 on both the T1 (holidays) and T2 (school term) surveys.

14. On the days that you didn’t get enough sleep, what was the major reason? (tick only one that best describes your situation)

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ This did not apply to me - I got enough sleep</td>
<td></td>
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<tr>
<td>☐ I had to get up earlier than I wanted</td>
<td>(please state why e.g. extra curricular activities, sport, family demands, job etc.)</td>
</tr>
<tr>
<td>☐ I stayed up too late</td>
<td>(please state why e.g. socializing, job, T.V., homework / study etc.)</td>
</tr>
<tr>
<td>☐ I slept badly</td>
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</table>
Appendix I

Perceived Reasons for Sleep Difficulties
Perceived Reasons for Sleep Difficulties

The Perceived Reasons for Sleep Difficulties items were presented in Questions 15 to 17 in both the T1 (holidays) and T2 (school term) surveys. The categorical responses were modelled on the similar environmental and physical options provided in Questions 25 and 33 on the School Sleep Habits Survey (see Appendix B). Cognitive reasons (“worried concerned about personal problems”, and “worried/concerned about school”) were developed for the present study.

We are interested in the reasons why you think you might have experienced difficulties going to sleep or staying asleep over the last 2 weeks of holidays (school term). If you never had trouble sleeping you can tick “does not apply to me” – but please, answer every question.

15. If you had trouble falling asleep over the last 2 weeks of the holidays what do you think was the main reason for this?

☐ This does not apply to me, generally I had no trouble falling asleep
☐ I wasn’t tired
☐ I was bothered by noise or light
☐ I was too hot / cold / uncomfortable
☐ I wasn’t well
☐ I needed to use the bathroom
☐ I was worried / concerned about personal problems
☐ I was worried / concerned about school
☐ Any other reasons?

______________________________________________
______________________________________________
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______________________________________________

______________________________________________

______________________________________________

______________________________________________
18. If **waking up in the night** bothered you over the last 2 weeks of holidays, what do you think was the **main** reason for this?

- This does not apply to me, generally I did not wake up in the night
- I wasn't tired
- I was bothered by noise or light
- I was too hot / cold / uncomfortable
- I wasn't well
- I needed to use the bathroom
- I was worried / concerned about personal problems
- I was worried / concerned about school
- Any other reasons?
  
  __________________________________________
  __________________________________________
  __________________________________________
  __________________________________________
  __________________________________________

19. If you were bothered by **waking up in the early hours of the morning and not being able to get back to sleep**, what do you think was the **main** reason for this?

(Don’t include **having** to wake up early for job, sport, practices etc.)

- This does not apply to me, generally I did not wake in the early hours of the
- I wasn’t tired
- I was bothered by noise or light
- I was too hot / cold / uncomfortable
- I wasn’t well
- I needed to use the bathroom
- I was worried / concerned about personal problems
- I was worried / concerned about school
- Any other reasons?
  
  __________________________________________
  __________________________________________
  __________________________________________
Appendix J

Substance Use
**Substance Use**

This five-item scale was presented in Question 19 on both the T1 (Holiday) and T2 (School Term) surveys. Coding of participant responses to each of the items is shown. Notes about each of the questions are included in italics, providing information about how the items were adapted or taken from other instruments.

<table>
<thead>
<tr>
<th>19. During the last two weeks of the holidays, (school term) how often did you.....</th>
<th>Never</th>
<th>Once or twice</th>
<th>Several times</th>
<th>Every day</th>
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</thead>
<tbody>
<tr>
<td>A. Use tobacco (cigarettes, cigars)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>B. Drink coffee or tea with caffeine?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>C. Drink soft drink / energy drink with caffeine (Coke, Pepsi, Red Bull, Lift +, V, Red Eye, Red Dragon, etc.)?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>D. Drink alcohol (beer, cider, wine, spirits)?</td>
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<td>2</td>
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<td>4</td>
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<tr>
<td>E. Use medication to help you sleep? (prescribed or over the counter)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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</table>

*Note: Items A, B, C, and D were taken from Question 44 a, b, c, and d on the School Sleep Habits Survey (Wolfson & Carskadon, 1998) (see Appendix B). The fifth item on Question 44 in the School Habits Survey asked about illicit drug usage. It was decided that this was inappropriate to include this item for the schools involved in the present study. Item E was added to the scale for the current study.*
Appendix K

Letter to Parents, Cover Letters for Surveys, and Participant Consent Forms
Dear Parents,

We are currently undertaking a study where we are looking at students’ sleep habits during the holidays and during school term. In particular we are interested in the amount and quality of sleep students obtain, and how this relates to their daytime alertness and mood. The project has been approved by the Swinburne University ethics committee, and we have received permission from the school to conduct the study.

Your daughter / son will shortly be invited to participate in this study. It would involve students filling out a short survey about their general sleep habits and daytime functioning and mood over the holidays.

Another similar questionnaire would be filled out during Term 3. All information is kept confidential, and no individuals will be identified in the study. By taking part in the study, your daughter /son will have the opportunity to reflect on their sleep habits and how this may be affecting their performance at school. Should you like further information about the study please contact the researcher, Suzanne Warner on 9859 9331.

If you do NOT want your daughter / son to participate in the study in 2003, would you please fill out the following form and return it to the school by Fri. Jan. 31st.
Thank you,

Dr. Greg Murray and Suzanne Warner
Swinburne University
Ph: 9214 8300

(Please fill in this form and return to the school if you DO NOT want your daughter / son to participate in the study)

RE: SLEEP HABITS SURVEY 2003

I do NOT wish my daughter /son to take part in the study

Student Name __________________________   Year Level__________
Parent/ Guardian Signature ________________    Date ______________
We are currently undertaking a study in which we are looking at students’ sleep habits and sleep difficulties, and comparing the amount of sleep students obtain during the holidays compared to the amount of sleep they get during school term.

The study involves filling out a questionnaire that asks about the time you usually went to bed and what time you usually woke up the next day during the holidays. There are also a number of questions that ask about your schedule, your alertness during the day and your mood.

We would then like to survey you again during Term 3. Once again there will be a sleep diary to fill in and the same series of questions, in order to compare the quality and quantity of your sleep during the school term. The questions would take about 15 – 20 minutes to answer, and all of your answers will be kept confidential by the researcher. No individual results or answers will be identifiable in the study. The results of the study will be used in a doctoral thesis and may be published in an academic journal.

We would welcome your participation in the study, which may give you some interesting insights into your sleep habits and how these may affect your day to day functioning. You would be free to withdraw from the study at any time, or choose not to answer the questions. If you would like to participate in the study, please complete the student consent form and return this to the researcher.
If you would like to discuss any of the issues raised in the survey please contact your year level co-ordinator or student welfare co-ordinator.

The researchers can also be contacted for further information, and will be happy to answer any questions you may have.

Suzanne Warner will be available on the day of the study to answer questions and can also be contacted on ph: 9859 7824

Dr. Greg Murray can be contacted on ph: 9214 8300

Other resources: Kids Helpline 1800 55 1800

PLEASE RETAIN THIS SHEET FOR YOUR INFORMATION

If you have any complaints about the way you are treated during the study, please direct enquiries to: The Chair, Social and Behavioural Science Research Ethics Committee, Swinburne University of Technology, P.O. Box 218, Hawthorn, 3122. Ph: (03) 9214 5223
Sleep Habits Survey

Participant Agreement
No:……….

I …………………………………………………………………… (your name),
Have read and understood the information about the Sleep Habits Survey. Any questions I have asked have been answered to my satisfaction. I agree to participate in the study, realizing that I can withdraw at any time. I agree that research data collected for the study may be published or provided to other researchers on the condition that anonymity is preserved and I cannot be identified.

Name of participant……………………………………………………..

Signature…………………………………………………………………………..

Date………………………………………………………………………………….
Your participation in the holiday sleep habits survey was greatly appreciated. This second survey now asks you about your sleep habits during term time. Please fill out the agreement form first.

I …………………………………………………………………… (your name), agree to participate in the second part of the sleep study, realizing that I can withdraw at any time. I agree that research data collected for the study may be published or provided to other researchers on the condition that anonymity is preserved and I cannot be identified.

Name of participant…………………………………………………………

Signature…………………………………………………………………………

Date………………………………………………………………………………
Appendix L

Correlation Matrices
## Correlation Matrix for Time 1

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**Note:**  
- \( n = 363 – 369 \),  
- * \( p < .05 \),  
- ** \( p < .01 \);  
- SMES = Superscience Morningness/Eveningness Scale;  
- SMFQ = Short Mood and Feelings Questionnaire;  
- DFS = Daytime Functioning Scale.
### Correlation Matrix for Time 2

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<td>27. Weekend Oversleep</td>
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<tr>
<td>29. Weekday Sleep Debt</td>
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<td>30. Sleep Quality Scale</td>
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<td>32. SMES</td>
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<td>33. Substance Use</td>
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<td>34. SMFQ</td>
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<tr>
<td>35. DFS</td>
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<td>36. Grades</td>
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</tr>
</tbody>
</table>

Note: \( n = 304 – 307, \) * \( p < .05, \) ** \( p < .01; \) SMES = Superscience Morningness/Eveningness Scale; SMFQ = Short Mood and Feelings Questionnaire; DFS = Daytime Functioning Scale.
Appendix M

Summary of Responses to Items on the Daytime Functioning Scale
### Daytime Functioning Scale at T1 (Holidays): Summary of Participant Responses

<table>
<thead>
<tr>
<th>Item</th>
<th>Everyday</th>
<th>Several Times</th>
<th>Once or Twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A: Feel satisfied with your sleep?</strong></td>
<td>15.2</td>
<td>57.1</td>
<td>25.9</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>B: Have difficulty waking up?</strong></td>
<td>10.5</td>
<td>30.4</td>
<td>34.6</td>
<td>24.6</td>
</tr>
<tr>
<td><strong>C: Feel sleepy during the day?</strong></td>
<td>12.4</td>
<td>38.6</td>
<td>36.5</td>
<td>12.4</td>
</tr>
<tr>
<td><strong>D: Doze off or nap when you didn’t want to</strong></td>
<td>2.1</td>
<td>11.8</td>
<td>27.7</td>
<td>58.4</td>
</tr>
<tr>
<td><strong>E: Have difficulty keeping your thoughts focused?</strong></td>
<td>7.4</td>
<td>23.8</td>
<td>41.5</td>
<td>27.2</td>
</tr>
<tr>
<td><strong>F: Have difficulty remembering things?</strong></td>
<td>6.6</td>
<td>19.7</td>
<td>37.0</td>
<td>36.7</td>
</tr>
<tr>
<td><strong>G: Have difficulty thinking clearly and making decisions?</strong></td>
<td>5.0</td>
<td>14.3</td>
<td>41.0</td>
<td>39.7</td>
</tr>
<tr>
<td><strong>H: Have others tell you that you look tired and fatigued?</strong></td>
<td>4.0</td>
<td>5.5</td>
<td>36.4</td>
<td>44.1</td>
</tr>
<tr>
<td><strong>I: Feel in a bad mood because of lack of sleep?</strong></td>
<td>3.4</td>
<td>22.2</td>
<td>38.6</td>
<td>35.7</td>
</tr>
<tr>
<td><strong>J: Feel irritated with other people even when they were polite?</strong></td>
<td>3.4</td>
<td>17.7</td>
<td>39.1</td>
<td>39.8</td>
</tr>
<tr>
<td><strong>K: Have difficulty controlling your emotions?</strong></td>
<td>3.7</td>
<td>16.4</td>
<td>36.5</td>
<td>43.4</td>
</tr>
<tr>
<td><strong>L: Have no energy because of lack of sleep?</strong></td>
<td>5.0</td>
<td>21.4</td>
<td>43.0</td>
<td>30.6</td>
</tr>
<tr>
<td><strong>M: Feel you were only able to do enough to get by?</strong></td>
<td>3.2</td>
<td>10.6</td>
<td>39.6</td>
<td>46.5</td>
</tr>
<tr>
<td><strong>N: Have difficulty getting along with others?</strong></td>
<td>1.1</td>
<td>8.8</td>
<td>33.2</td>
<td>56.9</td>
</tr>
<tr>
<td><strong>O: Feel physically clumsy?</strong></td>
<td>4.0</td>
<td>14.9</td>
<td>36.7</td>
<td>44.4</td>
</tr>
</tbody>
</table>

### Daytime Functioning Scale at T2 (School Term): Summary of Responses

<table>
<thead>
<tr>
<th>Item</th>
<th>Everyday</th>
<th>Several Times</th>
<th>Once or Twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A: Feel satisfied with your sleep?</strong></td>
<td>9.4</td>
<td>41.6</td>
<td>41.2</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>B: Have difficulty waking up?</strong></td>
<td>24.3</td>
<td>42.4</td>
<td>24.9</td>
<td>8.4</td>
</tr>
<tr>
<td><strong>C: Feel sleepy during the day?</strong></td>
<td>18.6</td>
<td>46.4</td>
<td>28.4</td>
<td>6.5</td>
</tr>
<tr>
<td><strong>D: Doze off or nap when you didn’t want to</strong></td>
<td>5.2</td>
<td>12.3</td>
<td>32.8</td>
<td>49.7</td>
</tr>
<tr>
<td><strong>E: Have difficulty keeping your thoughts focused?</strong></td>
<td>11.4</td>
<td>31.5</td>
<td>45.5</td>
<td>11.7</td>
</tr>
<tr>
<td><strong>F: Have difficulty remembering things?</strong></td>
<td>6.8</td>
<td>23.4</td>
<td>42.5</td>
<td>27.3</td>
</tr>
<tr>
<td><strong>G: Have difficulty thinking clearly and making decisions?</strong></td>
<td>6.8</td>
<td>16.6</td>
<td>43.5</td>
<td>33.1</td>
</tr>
<tr>
<td><strong>H: Have others tell you that you look tired and fatigued?</strong></td>
<td>6.1</td>
<td>19.1</td>
<td>44.0</td>
<td>30.7</td>
</tr>
<tr>
<td><strong>I: Feel in a bad mood because of lack of sleep?</strong></td>
<td>4.9</td>
<td>24.6</td>
<td>41.1</td>
<td>29.4</td>
</tr>
<tr>
<td><strong>J: Feel irritated with other people even when they were polite?</strong></td>
<td>6.9</td>
<td>18.6</td>
<td>38.2</td>
<td>36.3</td>
</tr>
<tr>
<td><strong>K: Have difficulty controlling your emotions?</strong></td>
<td>4.2</td>
<td>17.5</td>
<td>33.3</td>
<td>45.0</td>
</tr>
<tr>
<td><strong>L: Have no energy because of lack of sleep?</strong></td>
<td>8.1</td>
<td>30.7</td>
<td>39.8</td>
<td>21.4</td>
</tr>
<tr>
<td><strong>M: Feel you were only able to do enough to get by?</strong></td>
<td>7.8</td>
<td>23.3</td>
<td>36.2</td>
<td>32.7</td>
</tr>
<tr>
<td><strong>N: Have difficulty getting along with others?</strong></td>
<td>2.3</td>
<td>8.8</td>
<td>33.8</td>
<td>55.2</td>
</tr>
<tr>
<td><strong>O: Feel physically clumsy?</strong></td>
<td>6.8</td>
<td>12.3</td>
<td>37.5</td>
<td>43.4</td>
</tr>
</tbody>
</table>
Appendix N

Summary of Responses to Items on the Short Moods and Feelings Questionnaire
### Short Moods and Feelings Questionnaire Scale: Summary of Participant Responses in Percentages for T1 (Holidays)

<table>
<thead>
<tr>
<th>Item</th>
<th>% True</th>
<th>% Sometimes True</th>
<th>% Not True</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: I felt miserable or unhappy</td>
<td>5.1</td>
<td>43.4</td>
<td>51.6</td>
</tr>
<tr>
<td>C: I didn’t enjoy anything at all</td>
<td>2.1</td>
<td>16.2</td>
<td>81.6</td>
</tr>
<tr>
<td>D: I felt so tired I just sat around and did nothing</td>
<td>7.0</td>
<td>41.2</td>
<td>51.8</td>
</tr>
<tr>
<td>E: I was very restless (couldn’t sit still or quiet)</td>
<td>8.7</td>
<td>47.7</td>
<td>43.6</td>
</tr>
<tr>
<td>F: I felt I was no good any more</td>
<td>5.6</td>
<td>18.2</td>
<td>76.2</td>
</tr>
<tr>
<td>H: I cried a lot</td>
<td>7.1</td>
<td>14.9</td>
<td>78.0</td>
</tr>
<tr>
<td>I: I found it hard to think properly or concentrate</td>
<td>7.9</td>
<td>47.7</td>
<td>44.4</td>
</tr>
<tr>
<td>J: I hated myself</td>
<td>6.2</td>
<td>10.0</td>
<td>83.7</td>
</tr>
<tr>
<td>K: I was a bad person</td>
<td>4.0</td>
<td>15.5</td>
<td>80.5</td>
</tr>
<tr>
<td>M: I felt lonely</td>
<td>8.4</td>
<td>30.4</td>
<td>61.1</td>
</tr>
<tr>
<td>N: I thought nobody really loved me</td>
<td>4.6</td>
<td>13.7</td>
<td>81.8</td>
</tr>
<tr>
<td>O: I thought I could never be as good as other people</td>
<td>6.7</td>
<td>28.2</td>
<td>65.1</td>
</tr>
<tr>
<td>P: I did everything wrong</td>
<td>4.6</td>
<td>17.2</td>
<td>78.3</td>
</tr>
</tbody>
</table>

**Note:** Items B, G, L, & Q were not assessed. These items were from Rosenberg’s Self Esteem Scale and were included in the questionnaire only to improve the acceptability of the SMFQ scale for the current adolescent sample.

### Short Moods and Feelings Questionnaire): Summary of Participant Responses in Percentages for T2 (School Term)

<table>
<thead>
<tr>
<th>Item</th>
<th>% True</th>
<th>% Sometimes True</th>
<th>% Not True</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: I felt miserable or unhappy</td>
<td>10.4</td>
<td>49.8</td>
<td>39.7</td>
</tr>
<tr>
<td>C: I didn’t enjoy anything at all</td>
<td>3.9</td>
<td>29.6</td>
<td>66.4</td>
</tr>
<tr>
<td>D: I felt so tired I just sat around and did nothing</td>
<td>15.0</td>
<td>42.2</td>
<td>42.8</td>
</tr>
<tr>
<td>E: I was very restless (couldn’t sit still or quiet)</td>
<td>15.0</td>
<td>46.6</td>
<td>38.4</td>
</tr>
<tr>
<td>F: I felt I was no good any more</td>
<td>7.5</td>
<td>21.0</td>
<td>71.5</td>
</tr>
<tr>
<td>H: I cried a lot</td>
<td>7.8</td>
<td>16.9</td>
<td>75.2</td>
</tr>
<tr>
<td>I: I found it hard to think properly or concentrate</td>
<td>17.6</td>
<td>55.6</td>
<td>26.8</td>
</tr>
<tr>
<td>J: I hated myself</td>
<td>5.9</td>
<td>16.6</td>
<td>77.5</td>
</tr>
<tr>
<td>K: I was a bad person</td>
<td>4.6</td>
<td>18.6</td>
<td>76.9</td>
</tr>
<tr>
<td>M: I felt lonely</td>
<td>8.1</td>
<td>32.9</td>
<td>59.0</td>
</tr>
<tr>
<td>N: I thought nobody really loved me</td>
<td>4.6</td>
<td>15.7</td>
<td>79.7</td>
</tr>
<tr>
<td>O: I thought I could never be as good as other people</td>
<td>7.8</td>
<td>28.7</td>
<td>63.5</td>
</tr>
<tr>
<td>P: I did everything wrong</td>
<td>4.2</td>
<td>27.0</td>
<td>68.7</td>
</tr>
</tbody>
</table>

**Note:** Items B, G, L, & Q were not assessed. These items were from Rosenberg’s Self Esteem Scale and were included in the questionnaire only to improve the acceptability of the SMFQ scale for the current adolescent sample.
Appendix O

Summary of Responses to Grades & Substance Use Items
### Self-Reported Grades at T1 (Holidays) and T2 (School Term): Summary of Participant Responses in Percentages

<table>
<thead>
<tr>
<th>Reported Grades</th>
<th>% T1 (holidays)</th>
<th>% T2 (school term)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly A</td>
<td>18.5</td>
<td>18.1</td>
</tr>
<tr>
<td>Mostly A &amp; B</td>
<td>43.5</td>
<td>43.7</td>
</tr>
<tr>
<td>Mostly B</td>
<td>15.0</td>
<td>14.2</td>
</tr>
<tr>
<td>Mostly B &amp; C</td>
<td>19.8</td>
<td>19.1</td>
</tr>
<tr>
<td>Mostly C</td>
<td>1.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Mostly C &amp; D</td>
<td>1.3</td>
<td>1.9</td>
</tr>
<tr>
<td>Mostly D</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Mostly D &amp; E</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
### Substance Use Items at T1 (Holidays): Summary of Participant Responses in Percentages

<table>
<thead>
<tr>
<th>Item</th>
<th>Everyday</th>
<th>Several Times</th>
<th>Once or Twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the last 2 weeks, how often did you…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A: Use tobacco (cigarettes,cigars)?</td>
<td>4.2</td>
<td>6.1</td>
<td>6.6</td>
<td>83.1</td>
</tr>
<tr>
<td>B: Drink coffee or tea with caffeine?</td>
<td>14.6</td>
<td>22.5</td>
<td>27.6</td>
<td>35.3</td>
</tr>
<tr>
<td>C: Drink soft drink / energy drink with caffeine (Coke, Pepsi, Red Bull, Lift+, Red eye, Red Dragon etc.)?</td>
<td>15.6</td>
<td>42.1</td>
<td>27.5</td>
<td>14.8</td>
</tr>
<tr>
<td>D: Drink alcohol (beer, cider, wine, spirits)?</td>
<td>4.5</td>
<td>23.5</td>
<td>32.3</td>
<td>39.7</td>
</tr>
<tr>
<td>E: Use medication to help you sleep? (prescribed or over the counter)</td>
<td>1.6</td>
<td>0.8</td>
<td>6.9</td>
<td>90.7</td>
</tr>
</tbody>
</table>

### Substance Use Items at T2 (School Term): Summary of Participant Responses in Percentages

<table>
<thead>
<tr>
<th>Item</th>
<th>Everyday</th>
<th>Several Times</th>
<th>Once or Twice</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>During the last 2 weeks, how often did you…</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A: Use tobacco (cigarettes,cigars)?</td>
<td>4.5</td>
<td>5.8</td>
<td>7.8</td>
<td>81.9</td>
</tr>
<tr>
<td>B: Drink coffee or tea with caffeine?</td>
<td>21.4</td>
<td>19.4</td>
<td>23.3</td>
<td>35.9</td>
</tr>
<tr>
<td>C: Drink soft drink / energy drink with caffeine (Coke, Pepsi, Red Bull, Lift+, Red eye, Red Dragon etc.)?</td>
<td>12.3</td>
<td>314</td>
<td>35.9</td>
<td>20.4</td>
</tr>
<tr>
<td>D: Drink alcohol (beer, cider, wine, spirits)?</td>
<td>1.6</td>
<td>13.3</td>
<td>38.5</td>
<td>46.6</td>
</tr>
<tr>
<td>E: Use medication to help you sleep? (prescribed or over the counter)</td>
<td>1.0</td>
<td>2.9</td>
<td>4.9</td>
<td>91.3</td>
</tr>
</tbody>
</table>
Appendix P

Summary of Responses to Items on the Sleep Quality Scale
### Sleep Quality Scale Items at T1 (Holidays) and T2 (School Term): Summary of Participant Responses in Percentages

<table>
<thead>
<tr>
<th>Item and Possible Responses</th>
<th>% T1 (Holidays) Responses</th>
<th>% T2 (School Term) Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>8. Generally, how long did it take you to fall asleep?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As soon as my head hit the pillow</td>
<td>10.6</td>
<td>12.7</td>
</tr>
<tr>
<td>Less than 30 mins.</td>
<td>51.2</td>
<td>59.9</td>
</tr>
<tr>
<td>Between 30 mins. to 1 hour</td>
<td>26.6</td>
<td>22.5</td>
</tr>
<tr>
<td>Between 1 to 3 hours</td>
<td>8.9</td>
<td>4.0</td>
</tr>
<tr>
<td>More than 3 hours or I didn’t sleep</td>
<td>1.6</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>9. How many times did you usually wake at night?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>35.2</td>
<td>44.2</td>
</tr>
<tr>
<td>Once</td>
<td>37.1</td>
<td>37.3</td>
</tr>
<tr>
<td>Two or three times</td>
<td>16.3</td>
<td>12.3</td>
</tr>
<tr>
<td>More than three times</td>
<td>4.3</td>
<td>2.6</td>
</tr>
<tr>
<td>I have no idea</td>
<td>6.0</td>
<td>3.6</td>
</tr>
<tr>
<td><strong>10. Early morning waking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>48.1</td>
<td>59.4</td>
</tr>
<tr>
<td>Once</td>
<td>14.2</td>
<td>20.8</td>
</tr>
<tr>
<td>Two or three times</td>
<td>26.2</td>
<td>14.3</td>
</tr>
<tr>
<td>Often</td>
<td>9.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Everyday/night</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>11. In general, did you feel you usually got ..../</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too much sleep?</td>
<td>13.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Enough sleep?</td>
<td>55.9</td>
<td>32.5</td>
</tr>
<tr>
<td>Not enough sleep?</td>
<td>31.0</td>
<td>64.9</td>
</tr>
<tr>
<td><strong>12. Did you consider your overall sleep quality to be..</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>40.5</td>
<td>30.2</td>
</tr>
<tr>
<td>Average</td>
<td>47.1</td>
<td>57.1</td>
</tr>
<tr>
<td>Poor</td>
<td>12.3</td>
<td>12.7</td>
</tr>
<tr>
<td><strong>13. How often did you think you got enough sleep?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td>10.8</td>
<td>3.2</td>
</tr>
<tr>
<td>Usually</td>
<td>45.0</td>
<td>30.2</td>
</tr>
<tr>
<td>Sometimes</td>
<td>28.2</td>
<td>35.4</td>
</tr>
<tr>
<td>Rarely</td>
<td>13.6</td>
<td>27.6</td>
</tr>
<tr>
<td>Never</td>
<td>2.4</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Appendix Q

Summary of Responses to Perceived Reasons for Sleep Difficulties
Perceived Reasons for Sleep Difficulties at T1 (Holidays) and T2 (School Term): Summary of Participant Responses in Percentages

**Item 15.** If you had trouble falling asleep over the last 2 weeks what do you think was the main reason for this?

<table>
<thead>
<tr>
<th>Possible Responses</th>
<th>% Responses T1</th>
<th>% Responses T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>This doesn’t apply to me, generally I had no trouble falling asleep</td>
<td>29.5</td>
<td>36.9</td>
</tr>
<tr>
<td>I wasn’t tired</td>
<td>23.1</td>
<td>14.6</td>
</tr>
<tr>
<td>I was bothered by noise or light</td>
<td>6.5</td>
<td>8.1</td>
</tr>
<tr>
<td>I was too hot/cold/uncomfortable</td>
<td>27.4</td>
<td>7.5</td>
</tr>
<tr>
<td>I wasn’t well</td>
<td>3.0</td>
<td>11.0</td>
</tr>
<tr>
<td>I needed to use the bathroom</td>
<td>.3</td>
<td>3.9</td>
</tr>
<tr>
<td>I was worried/concerned about personal problems</td>
<td>16.0</td>
<td>17.9</td>
</tr>
<tr>
<td>I was worried/concerned about school</td>
<td>6.0</td>
<td>14.3</td>
</tr>
<tr>
<td>Other reasons</td>
<td>14.7</td>
<td>12.7</td>
</tr>
<tr>
<td>Other reason, but no theme given</td>
<td>0.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Active mind/thinking</td>
<td>7.9</td>
<td>6.8</td>
</tr>
<tr>
<td>Body clock/sleep patterns</td>
<td>3.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Don’t know why</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Other themes</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Note:** Although participants were asked to choose the main reason that best described their situation, some participants indicated that more than one response was applicable to them. Consequently the percentages displayed may total in excess of 100%.
**Item 16.** If waking up in the night bothered you over the last 2 weeks, what do you think was the main reason for this?

<table>
<thead>
<tr>
<th>Possible Responses</th>
<th>% Responses</th>
<th>% Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>This doesn’t apply to me, generally I did not wake up in the night</td>
<td>43.6</td>
<td>48.5</td>
</tr>
<tr>
<td>I wasn’t tired</td>
<td>3.3</td>
<td>4.6</td>
</tr>
<tr>
<td>I was bothered by noise or light</td>
<td>9.8</td>
<td>4.9</td>
</tr>
<tr>
<td>I was too hot/cold/uncomfortable</td>
<td>23.9</td>
<td>9.8</td>
</tr>
<tr>
<td>I wasn’t well</td>
<td>3.3</td>
<td>8.8</td>
</tr>
<tr>
<td>I needed to use the bathroom</td>
<td>14.4</td>
<td>16.3</td>
</tr>
<tr>
<td>I was worried/concerned about personal problems</td>
<td>6.5</td>
<td>6.8</td>
</tr>
<tr>
<td>I was worried/concerned about school</td>
<td>2.2</td>
<td>4.6</td>
</tr>
<tr>
<td>Other reasons</td>
<td>8.9</td>
<td>8.5</td>
</tr>
<tr>
<td>No theme given</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>Active mind/thinking</td>
<td>2.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Body clock/sleep patterns</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Don’t know why / no apparent reason</td>
<td>2.4</td>
<td>2.9</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>0.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Dreams/nightmares</td>
<td>2.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Other themes</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Note:** Although participants were asked to choose the main reason that best described their situation, some participants indicated that more than one response was applicable to them. Consequently the percentages displayed may total in excess of 100%.
**Item 17.** If you were bothered by waking up in the early hours of the morning and not being able to get back to sleep, what do you think was the main reason for this?

<table>
<thead>
<tr>
<th>Possible Responses</th>
<th>% Responses T1</th>
<th>% Responses T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>This doesn’t apply to me, generally I did not wake up in the early hours of the morning</td>
<td>50.0</td>
<td>59.6</td>
</tr>
<tr>
<td>I wasn’t tired</td>
<td>11.5</td>
<td>4.2</td>
</tr>
<tr>
<td>I was bothered by noise or light</td>
<td>12.6</td>
<td>8.1</td>
</tr>
<tr>
<td>I was too hot/cold/uncomfortable</td>
<td>8.4</td>
<td>6.5</td>
</tr>
<tr>
<td>I wasn’t well</td>
<td>1.3</td>
<td>5.2</td>
</tr>
<tr>
<td>I needed to use the bathroom</td>
<td>7.3</td>
<td>6.5</td>
</tr>
<tr>
<td>I was worried/concerned about personal problems</td>
<td>3.4</td>
<td>5.9</td>
</tr>
<tr>
<td>I was worried/concerned about school</td>
<td>1.3</td>
<td>6.2</td>
</tr>
<tr>
<td>Other reasons</td>
<td>10.1</td>
<td>5.9</td>
</tr>
<tr>
<td>No theme given</td>
<td>1.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Active mind/thinking</td>
<td>1.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Body clock/sleep patterns</td>
<td>2.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Don’t know why / no apparent reason</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Mobile phone</td>
<td>0.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Dreams/nightmares</td>
<td>0.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Other themes</td>
<td>2.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

**Note:** Although participants were asked to choose the main reason that best described their situation, some participants indicated that more than one response was applicable to them. Consequently the percentages displayed may total in excess of 100%.
Appendix R

Summary of Responses to Perceived Reasons for Insufficient Sleep
**Perceived Reasons for Insufficient Sleep at T1 (Holidays) and T2 (School Term): Summary of Participant Responses in Percentages**

**Item:** On the days that you didn’t get enough sleep, what was the major reason?

<table>
<thead>
<tr>
<th>Possible Responses</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>This did not apply to me – I got enough sleep</td>
<td>12.5</td>
<td>9.8</td>
</tr>
<tr>
<td>I had to get up earlier than I wanted</td>
<td>33.3</td>
<td>35.5</td>
</tr>
<tr>
<td>Why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No comment</td>
<td>68.0</td>
<td>69.6</td>
</tr>
<tr>
<td>School</td>
<td>0.0</td>
<td>19.9</td>
</tr>
<tr>
<td>Sport/extra curricular</td>
<td>8.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Job</td>
<td>11.9</td>
<td>1.7</td>
</tr>
<tr>
<td>Family demands</td>
<td>6.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Social</td>
<td>2.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Other</td>
<td>2.4</td>
<td>1.7</td>
</tr>
<tr>
<td>I stayed up too late</td>
<td>45.8</td>
<td>52.4</td>
</tr>
<tr>
<td>Why?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No comment</td>
<td>64.0</td>
<td>60.5</td>
</tr>
<tr>
<td>Homework</td>
<td>0.0</td>
<td>11.8</td>
</tr>
<tr>
<td>Socialising</td>
<td>21.4</td>
<td>14.5</td>
</tr>
<tr>
<td>TV, computer</td>
<td>8.7</td>
<td>6.8</td>
</tr>
<tr>
<td>Job</td>
<td>1.1</td>
<td>3.4</td>
</tr>
<tr>
<td>Reading</td>
<td>1.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Other</td>
<td>3.5</td>
<td>2.4</td>
</tr>
<tr>
<td>I slept badly</td>
<td>11.9</td>
<td>12.9</td>
</tr>
</tbody>
</table>

**Note:** Although participants were asked to choose the main reason that best described their situation, some participants indicated that more than one response was applicable to them. Consequently the percentages displayed may total in excess of 100%.
Appendix S

Means & Standard Deviations for Change Data (T1-T2)
## Means and Standard Deviations for Change Data (T1 – T2)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min.</th>
<th>Max.</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Quality</td>
<td>-9.00</td>
<td>9.00</td>
<td>0.01</td>
<td>2.7</td>
<td>-0.12</td>
<td>0.15</td>
</tr>
<tr>
<td>Weekday Sleep</td>
<td>-257.00</td>
<td>414.00</td>
<td>75.77</td>
<td>93.00</td>
<td>0.16</td>
<td>0.75</td>
</tr>
<tr>
<td>Sleep Debt</td>
<td>-366.00</td>
<td>222.00</td>
<td>-73.82</td>
<td>94.08</td>
<td>-0.05</td>
<td>1.04</td>
</tr>
<tr>
<td>Weekend Oversleep</td>
<td>-468.00</td>
<td>429.00</td>
<td>-74.23</td>
<td>134.78</td>
<td>-0.32</td>
<td>0.80</td>
</tr>
<tr>
<td>Weekend Delay</td>
<td>-357.00</td>
<td>150.00</td>
<td>-50.95</td>
<td>78.26</td>
<td>-0.38</td>
<td>0.84</td>
</tr>
<tr>
<td>SMFQ</td>
<td>-15.29</td>
<td>15.00</td>
<td>1.25</td>
<td>4.14</td>
<td>0.05</td>
<td>2.42</td>
</tr>
<tr>
<td>DFS</td>
<td>-25.00</td>
<td>34.00</td>
<td>2.93</td>
<td>7.53</td>
<td>0.29</td>
<td>0.16</td>
</tr>
<tr>
<td>Grades</td>
<td>-2.00</td>
<td>3.00</td>
<td>0.09</td>
<td>0.84</td>
<td>0.10</td>
<td>1.01</td>
</tr>
</tbody>
</table>

*Note: n = 307; Weekday Sleep, Sleep Debt, Weekend Oversleep and Weekend Delay are in minutes; SMFQ = Short Moods and Feelings Questionnaire; DFS = Daytime Functioning Scale; + indicates transformed SMFQ scale scores.*