Summer 2017

The Relationship of Early Class Start Times on Sleepiness and Driving Behaviors in an Emerging Adult Population

Jessica L. Fry
Old Dominion University

THE RELATIONSHIP OF EARLY CLASS START TIMES ON SLEEPINESS AND DRIVING BEHAVIORS IN AN EMERGING ADULT POPULATION

by

Jessica L. Fry
B.S. 2014, Old Dominion University

A Thesis Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

PSYCHOLOGY

OLD DOMINION UNIVERSITY

August 2017

Approved by:

Bryan E. Porter (Director)

Michelle L. Kelley (Member)

Yusuke Yamani (Member)

ABSTRACT

THE RELATIONSHIP OF EARLY CLASS START TIMES ON SLEEPINESS AND DRIVING BEHAVIORS IN AN EMERGING ADULT POPULATION

Jessica L. Fry
Old Dominion University, 2017
Director: Dr. Bryan E. Porter

Teenage driver sleepiness is a recent concern for preventing motor vehicle fatalities. Early school start times limit the amount of sleep teenage high school students acquire during the week and have been related to increased crash risk. The current study extends this finding to teenage and emerging adult college students. The author examined the link between sleepiness and teenage driving behaviors, including the relationship between school start times and sleepiness. In all, 536 participants were recruited to participate in an online survey assessing driving and sleep behaviors. Correlations and path analysis found that sleepiness fully mediated the relationship between early class start times and driving behaviors. Surprisingly only daytime sleepiness (as measured by the ESS), not sleep quality (as measured by the PSQI), mediated this relationship. Furthermore, both driving errors and driving violations were related outcomes to class start time as mediated by sleepiness, with hypotheses only expecting errors to be so. Reasons for violations being predicted when unexpected are discussed. Overall, this study adds to a growing literature supporting the influence of later class start times, and indicates that college students may be at similar driving risk as high school teenagers with early class start times.

TABLE OF CONTENTS

Page

LIST OF TABLES…………………………………………………………………………….v

LIST OF FIGURES…………………………………………………………………………...vi

Chapter

I. INTRODUCTION……………………………………………………………….....1

DEFINING DROWSY DRIVING AND SCOPE OF PROBLEM………………2

SLEEPINESS: DISTRACTED DRIVING OR IMPAIRED DRIVING?..............3

SLEEPINESS AS AN IMPAIRMENT…………………………………………..5

SLEEPINESS IMPAIRMENT AND HOW IT RELATES TO ERRORS……......6

TEENAGE DRIVERS: AGE AND INEXPERIENCE…………………………..6

SLEEPINESS IN TEENAGERS: DEVELOPMENTAL CHANGES

AFFECTING SLEEP……………………………………………………………..8

CHALLENGES AFFECTING SLEEP IN COLLEGE STUDENTS………….....9

SCHOOL START TIMES……………………………………………………….10

SCHOOL START TIMES AND CRASH RISK………………………………...11

COLLEGE STUDENTS VS. HIGH SCHOOL STUDENTS…………………...13

HYPOTHESES…………………………………………………………………..13

II. METHOD………………………………………………………………………….16

PARTICIPANTS………………………………………………………………...16

Page

MEASURES……………………………………………….……………....16

PROCEDURE……………………………………….……………….…20

III. RESULTS…………………………………………………….…………......22

DATA PREPARATION……………………………..…………………...…22

CORRELATIONS…………………………………………………………….23

MODEL AND HYPOTHESIS TESTING……………………………………26

EXPLORATORY ANALYSIS……………………………………………….35

IV. DISCUSSION…………………………………………………………………37

PSQI VS. ESS……………………………………………………………………37

ERRORS AND VIOLATIONS……………………………………………….38

THE LACK OF RELATIONSHIP BETWEEN COMMUTER STATUS AND AGE……………………………………………………………………...40

LIMITATIONS OF THE STUDY……………………………………………41

FUTURE DIRECTIONS……………………………………………………...42

IMPLICATIONS FOR THE FUTURE………………………………………43

REFERENCES…………………………………………………………………………..44

APPENDICIES………………………………………………...…………………………52

VITA……………………………………………………………………………………..63

LIST OF TABLES

Table Page

1. Descriptive Statistics………………………………………………………………..…….22

2. Pearson Correlation Matrix…………………………………………………………………25

LIST OF FIGURES

Figure Page

1. Hypothesized partial mediation model of relationships among early school start times, sleepiness, and driving errors……………..……………………………………………………..14

2. Hypothesized non-significant relationships among school start times, sleepiness, and driving violations……………………………………………………………………………………15

3. Correlations between Sleepiness Variables and Errors……………………………………….26

4. Correlations between Sleepiness Variables and Violations…………………………..………..27

5. Correlations between Early Class Start and Sleepiness Variables……………………….……28

6. Process Model 4 Conceptual and Statistical Diagrams……………………………………..29

7. Path Coefficients between Class Start Time, ESS, PSQI, and Errors…………………………31

8. Path Coefficients between Class Start Time, ESS, PSQI, and Violations…………………….31

9. Path Coefficients excluding PSQI from the model (Errors)…………………………………..32

10. Path Coefficients excluding PSQI from the model (Violations)…………………………….32

11. Model 7 Moderated Mediated Conceptual and Statistical Diagrams………………………..33

12. Age Moderation-ESS Mediation, (Errors), Statistical Model………………………………..34

13. Age Moderation-ESS Mediation, (Violations), Statistical Model…………………………...35

14. Commuter Status Moderation-ESS Mediation, (Errors), Statistical Model…………………36

15. Commuter Status Moderation-ESS Mediation, (Violations), Statistical Model...…………..36

CHAPTER 1

INTRODUCTION

The leading cause of death among teenagers (16 to 19-year-olds) is unintentional injury (Centers for Disease Control, 2016). Unintentional injuries account for more than half of all teenage deaths, with motor-vehicle deaths being one-third of those deaths (CDC, 2016). The "Eight Danger Zones" identified by the CDC, that put teenagers at the most risk for crash while driving are driver inexperience, reckless driving, driving with peers, night time driving, drowsy driving, being unbuckled, distracted driving, and impaired driving.

Many of these danger zones have interventions and programs in place for prevention. For example, graduated licensing programs have been implemented across the nation to prevent inexperienced teens from driving at night and with teen passengers (Zhu et al., 2012). There have been multiple interventions like Click it or Ticket that has used enforcement to target seat-belt usage (National Highway Traffic Safety Administration, 2016). In the relatively new realm of texting and driving, media campaigns, and other programs have been created to prevent texting and driving, especially in this 16 to 19-year-old demographic. Finally, policy changes including passing primary laws for driving without a seat-belt, or driving while impaired, have helped combat these teen crashes (Insurance Institute for Highway Safety, 2016).

Drowsy driving is the one danger zone that has not received as much attention or policy focus as others. Drowsy driving is defined as "…the operation of a motor vehicle while impaired by a lack of adequate sleep. This impairment can be due to a chronic condition (undiagnosed sleep disorder, or chronic partial sleep deprivation), or an acute effect (staying awake for 18+ hours)" (Watson et al., 2015, p. 1). Research on drowsy driving began in earnest in the early

2000s. Although time does not necessarily dictate how much knowledge has been gained in this 15-year span, it does illustrate how drowsy driving is a new concern when compared to the other danger zones, such as seat-belt usage which has been researched over several decades (Slovic, Fischhoff, & Lichtenstein, 1978).

This document expands upon the drowsy driving literature, and highlights that drowsy driving is a problem for teens that needs to be confronted. The author also wants to stress in the following pages how important early high school start times are, and how they further complicate this problem. Early high school start times limit the amount of sleep teenagers acquire during the week, while these same teens are already predisposed to sleep deprivation (Dahl, 2008). This study examined the relationships among college early class start times, sleepiness, and driving behaviors to ascertain if early class start times impacts on sleepiness and driving are similar to those observed in high schools. The author also compared teenagers in college to their older (ages 20 and above) classmates. The comparison of the two allowed the assessment of teen driving vs. emerging adult driving differences.

Defining Drowsy Driving and Scope of Problem

Throughout this review, the author will be using the current literature's term "drowsy driving". However, when it comes to measurement the author will be assessing sleepiness. The definition of drowsy is "sleepy, lethargic, or causing sleepiness". Based off this definition, sleepiness is a good construct to measure for assessing drowsy driving risk.

Adequate sleep is operationalized as sleeping 8-10 hours a night for teenagers, and 7-9 hours for adults (National Sleep Foundation, 2016). Not receiving adequate sleep whether due to sleep disorders, or sleep deprivation, can lead to sleepiness (the state of being sleepy). It is sleepiness that can cause motor vehicle crashes.

It is hard to know exactly how many motor vehicle crashes are sleep related due to underreporting or reporting other causes for the crash or death (i.e., not wearing a seat-belt, speeding, swerving). But in the United States, NHTSA's FARS (2014) reported 846 fatalities in 2014 that were drowsy-driving (i.e., sleepiness) related. Two other studies attempted to gain an idea of the prevalence of drowsy driving through self-report. The National Survey of Distracted and Drowsy Driving Attitudes and Behaviors Report (2002) gathered data from telephone interviews from a nationally representative sample of drivers aged 16 and older. The authors concluded that 37% of these drivers had nodded off or fallen asleep at least once. Drowsy driving was most prevalent among 21 to 29 year olds (13%) and males (11%) (NHTSA, 2002). Finally, the typical drowsy driving experience was associated with an average of six hours of sleep, with 24% of the sample receiving less than five hours. These results show that although there are not many drowsy driving crashes reported, drowsy driving is still prevalent in the US population, especially for young adults and male drivers.

To provide perspective on the international culture of drowsy driving, a 2014 study surveyed 19 countries in Europe on sleep and driving habits. Results indicated that on average 17% of participants had fallen asleep while driving in the past two years. This subset of the sample who indicated they had fallen asleep, had an average 7% prevelance of sleep-related crashes (Goncalves et al., 2014). Drowsy driving is a problem in other countries besides the US. Similar to the US population, younger age, male gender, and higher daytime sleepiness were all related to drowsy driving. This is especially concerning because the author expected the target population to have most of these characteristics.

Sleepiness: Distracted or Impaired Driving?

There has been some discussion in the literature, and in police reporting, about whether sleepiness is a form of distracted or impaired driving. This classification is important because it can determine how we handle drowsy driving in the future with regards to education and intervention planning.

Distracted driving is defined by the NHTSA as: "…Any activity that could divert a person's attention away from the primary task of driving. All distractions endanger driver, passenger and bystander safety. These types of distractions include texting, using a cell phone, eating, talking to passengers, etc." (NHTSA, 2016). Impaired driving is instead usually defined as driving while under the influence of alcohol or drugs, although NHTSA has noted that in the case of drowsy driving, sleepiness is the impairment (NHTSA, 2008).

Those who say drowsy driving is a form of distracted driving point to how the psychological and physical symptoms of sleep deprivation and sleepiness bring about distraction. Psychologically, sleep deprivation can cause feelings of disinclination to continue driving, weariness, and reduced motivation. Physiologically, sleep deprivation causes increased weaving, decreased reaction time, yawning, head nodding, and eye dropping (May, 2011). These symptoms all affect a driver's attention.

Those who consider drowsy driving an impairment liken it to the effects alcohol has on a person's body. Indeed, some have found that sleep deprivation is even worse than alcohol influence. In one study, subjects were sleep deprived for up to 19 hours before being tested in a driving simulator. Their driving performance was equivalent, or worse than their driving performance with a blood alcohol concentration of .05 (Williamson & Feyer, 2000). Considering most countries have laws preventing driving while intoxicated at this BAC level, it is telling and concerning sleepiness may produce the same deficits. For these reasons, and given the original NHTSA definition, the author has chosen to view drowsy driving as impaired driving.

Sleepiness as an Impairment

As previously mentioned, drowsy driving is defined as "the operation of a motor vehicle while impaired by a lack of adequate sleep" (Watson et al., 2015, p. 1). Sleepiness can cause drowsy driving related crashes because it diminishes a person's behavior in specific ways that make it unsafe to drive a vehicle. Impairments include slower reaction times, reduced vigilance, and deficits in information processing. Having an increased reaction time can make it difficult to avoid a crash. At high speeds, minute increases in reaction time can substantially effect crash risk. Finally, deficits in information processing can mean processing and integrating information takes longer, causing an individual's driving performance to decline (Strohl, et al. 2015). These impairments, when taken together show that a sleepy individual is at greater risk for crash and injury due to slow reflexes and lack of environmental awareness.

In fact, these same impairments can be seen in the characteristics of drowsy driving crashes. One characteristic reported includes drivers not making attempts to avoid crashing because of reduced vigilance and reaction time. Many drowsy driving crashes involve a single vehicle leaving the road (Strohl, et al., 2015).

Sleepiness Impairment and How It Relates to Driving Errors

Traditionally, driving errors are known as the failure of planned actions to go as planned, which may result in potentially dangerous outcomes. Lapses are like errors, but reflect inattention or mistakes. Violations are deliberate deviations from practices believed necessary to maintain safe operation of a vehicle (e.g., purposefully driving through a red light, or cutting off another driver; Bener, Özkan, & Lajunen, 2008). Principal component analysis has shown that errors are statistically different from violations, suggesting that errors and violations come from two different psychological mechanisms. Additionally, unsafe acts can be divided into unintended (slip, and lapse), and intended actions (mistake, and violations) (Reason, 1990). In some literature, slips, lapses, and mistakes, are all considered different types of errors. "Errors reflect performance limits of the driver such as those related to perceptual (slip), attentional (lapse), and information processing abilities (mistake)." (Reason, 1990, p. 270) Sleepiness impacts seem likely to affect these more cognitive abilities. Violations, however, reflect a driving style or habits (de Winter & Dodou, 2010) which sleepiness is not expected, at least per its major impacts, to affect. Furthermore, violations can be divided between ordinary and aggressive violations. Ordinary violations have no aggressive motive, but are still intentional, and aggressive violations have an emotional or interpersonal drive. Again, because the main effects of sleepiness are more cognitively based, the author did not believe mood/emotion would be affected. Therefore, violations should not significantly correlate with reported levels of sleep. Since the author believed errors, and violations, even ordinary violations, are conceptually different from one another, the author used the full violation scale of the Driving Behavior Questionnaire. **The author proposed hypotheses 1a and 1b, that greater reported levels of sleepiness would positively correlate with higher numbers of self-reported driving errors, and greater reported levels of sleepiness would not correlate with the number of self-reported driving violations.**

Teenage Drivers: Age and Inexperience

Teens are at an increased risk for sleepiness-related crashes for two reasons. One, they are inexperienced with driving and two, they are predisposed to sleepiness. First, the author will discuss the impacts of inexperience and age before discussing sleepiness in teenagers.

As previously mentioned, it is not just drowsy driving that puts teens at risk for motor-vehicle crashes. There are seven other noted danger zones (driver inexperience, driving with teen passengers, night time driving, not using seatbelts, distracted driving, reckless driving, and impaired driving; CDC, 2016) that increase their risk. Some of these are just as risky or adults (such as driving without a seatbelt and distracted driving. However, teens are nearly three times more likely to be in a fatal crash than drivers aged 20 and older (Insurance Institute for Highway Safety, 2012). What puts teenagers at a higher risk compared to adults? A considerable amount of research points to a teenager's inexperience with driving and their age.

In the US, licensing varies greatly from coast to coast. In South Dakota, an individual can drive starting at the young age of 14 years and 3 months, whereas in New Jersey one is required to wait until age 17 (Insurance Institute for Highway Safety, 2013). Such differences in laws lead to a range in age and experience of teenagers driving on the road.

How long (in years and months) a person has been driving has often been used as a way of quantifying how much experience an individual has with driving. This amount of time has shown to predict crash likelihood. A study examining a New Jersey database of intermediate licensed drivers aged 17-20, containing linked crash data from 2006-2009, determined that those who were licensed later older had lower crash rates in the initial months of driving, and a more stable rate of decline in crashes. Those licensed as soon as they were eligible (17 years, 0 months) had higher initial crash rates before experiencing a steep decline in crashes followed by a slow, steady decline in crash rates. Also, at each age, those with more driving experience had lower crash rates than their peers (Curry, Pfeiffer, Durbin, & Elliott, 2015). Experience matters even for first-time, older drivers. A 2006 review found drivers who are 30 years old and learning to drive for the first time are more prone to crashes than those with more experience but at the same age (Groeger, 2006).

Sleepiness in Teenagers: Developmental Changes Affecting Sleep

Teenagers are already more at risk while driving than any other age group, but during this developmental period teens also have an increase in sleepiness. Teenagers go through many social behavioral changes, many of which can affect their sleep. Dahl, reports "Key social and behavioral factors include: less parental control over bedtime, social interactions with peers, homework, sports hobbies, part-time employment, and the use of electronic media at night…" (p.282). These changes affect how soon teens fall asleep and decrease the amount of sleep teens get.

Teens have an increase in reproductive hormones, cortical development in the frontal and parietal regions of their brains and rapid physical growth due to puberty (Dahl, 2008). These biological changes related to puberty play a key role in a teens' acquisition of sleep (Hagenauer, Perryman, Lee & Carskadon, 2009). One study indicated pre-pubescent adolescents had identical dissipation rates of sleep pressure -what makes an individual want to fall asleep yet the buildup of this pressure was slower in post-puberty children (Jenni, Van Reen, & Carskadon, 2005). Girls also show a delay in timing of sleep one year earlier than boys, which parallels their earlier puberty onset (Roenneberg et al. 2004). Another study showed that more mature adolescents were slower to fall asleep relative to younger adolescents (Taylor, Jenni, Acebo, & Carskadon, 2005). The social, behavioral, and biological changes all interact to cause teens to not only have daytime sleepiness, but also a sleep shift/delayed-sleep phasing, meaning they have the tendency to prefer later bedtimes and later rising (eveningness chronotype) (Dahl, 2008).

This natural tendency toward an eveningness chronotype (night owl) is so severe that 40% of teens find it impossible to fall asleep before midnight (Giannotti et al., 2002). This phase delay is important for the current study's purpose because it means that teenagers are unable to fall asleep earlier in the evening yet often need to wake up early for school. High school students are severely sleep deprived with 87% reporting insufficient sleep on school nights (less than the recommended 8-10 hours; Hirshkowitz et al., 2015). They also experience high day-time sleepiness with 44% percent of students reporting serious difficulty staying awake in school (Calamaro et al., 2009). Seniors in high school report the least sleep, averaging less than 7 hours per night (Carskadon et al., 2014).

Many think that "catching up" on sleep over the weekends can help students who are not getting sleep during the week. This notion is false in that catching up on sleep over the weekends or holidays has negative consequences. It can worsen the circadian disruption and morning sleepiness. This is due to the body finding it easier to adjust to a phase delay. A phase delay is when the circadian rhythm has been delayed by two or more hours. For example, if an individual would normally fall asleep at 10:00 pm, in a phase delay the individual would naturally fall asleep around 12:00 am instead. A phase advance on the other hand is when your body has to accommodate earlier sleep schedules, like the difference between waking up at 10:00 am on the weekends, and waking up at 6:00am on the weekdays (Dahl, 2008). When students attempt to "catch-up" on sleep on the weekends, pushes the entire circadian rhythm back (to an even later start), and can it leads to even more imbalance in their sleep schedule. This cycle of less than optimal amounts of sleep followed by "catch up" sleep in large amounts is why school start times are such an important factor when discussing sleepy teen drivers.

Challenges Affecting College Students' Sleep

College students are at just as much risk for daytime sleepiness and sleep deprivation as teenagers, with 50% reporting daytime sleepiness (compared to just 36% in adolescents and adults) and 70% attaining insufficient sleep (less than 8 hours of sleep) (Hershner & Chervin, 2014). The consequences of sleep deprivation and daytime sleepiness are especially problematic for college students in that both can result in lower grade point averages, compromised learning, impaired mood, and increased risk of motor vehicle accidents (Hershner & Chervin, 2014). In addition to the puberty-related changes college students are still going through transitioning from high-school, college students must deal with additional obstacles and challenges such as alcohol consumption which negatively affects sleep. Alcohol consumption increases fragmented sleep, decreases sleep overall, and contributes to poorer sleep quality (Kenney, LaBrie, Hummer, & Pham, 2012). Alcohol consumption also increases and work/school related stress (Hershner & Chervin, 2014). Because teenagers and college students already have additional risks for sleepy driving, compounded by driving inexperience and developmental changes affecting sleep, it is important to consider ways to decrease drowsy driving to combat these risks. One of these interventions is to target school start times.

School Start Times

Across the US, the average high school start time is 8:00 am, with 9% of high schools nationwide starting before 7:30 am (NCES n.d). “High school start time is a stronger predictor of adolescent sleep quantity than bedtimes, bedtime routines, and time spent doing homework.” (Knutson & Lauderdale, 2009 p. 1).

Previous research has already found delaying school start time to have a positive effect on students. When one boarding school delayed their school start time by 25 minutes (8:25am) for one semester, before reverting it back to its original time during the spring semester (8:00am), they saw a 29-minute increase in sleep length during the school week. Also, students receiving the recommended eight or more hours of sleep doubled (18% to 44%). Outside of sleep duration, other improvements were seen as well. Daytime sleepiness, depressed mood, and caffeine use were all significantly reduced after the delay. Furthermore, results suggest sleep duration reverted to baseline levels once the school start time returned to its original time of 8:00 am (Boergers, Gabel, & Owens, 2014). These results show the direct benefits of delaying school start time on teen sleepiness. They also show how many benefits can come from a start delay of less than 30 minutes.

These same benefits were seen county wide, after a Kentucky county changed their school start times from 7:30 am (high school), and 8:00 am (middle school) to 8:30 am (high school) and 9:00 am (middle school). In a two-year study, data showed that delaying high school start times by an hour increased nightly sleep from year one to year two by 12 minutes (for 9th graders who had the most amount of sleep baseline) and 30 minutes (for 12th graders who had the least amount of sleep baseline), while decreasing weekend “catch up” sleep. The number of students who received more than eight hours of sleep also rose from 35% to 50% (Danner &

Phillips, 2008). These results, again, show that delays in school start times can have dramatic effects on students.

Recently, many of the same relationships that were found in high school students have been found in college students with regards to class start times. In a sample of 255 college students, analysis revealed that those with later class start times slept longer, experienced less daytime sleepiness, and were less likely to miss a class (Onyper, Thacher, Gilbert, & Gradess, 2012). Considering the literature on school start times, **the author proposed Hypothesis 2: earlier class start times for college students would positively correlation with higher amounts of sleepiness**.

School Start Times and Crash Risk

Although delaying school starts can have positive benefits, mainly by reducing sleepiness in students, until recently research had not demonstrated whether this delay would decrease traffic crashes. In a previously mentioned study, Danner and Phillips (2008) also found a 16.5% decrease in teen crashes over two years following the school-start delay in one school district located in Kentucky.

Investigating school start times and crash risk in a teen population, Vorona et al. (2011, 2014) compared two cities and two counties. They were interested in teen crash rates in the morning. In the first study, they compared two Southeast Virginia cities. One city (Virginia Beach) had a one hour earlier high school start time of 7:25 am while another city (Cheseapeake) had a high school start time of 8:40 am. They found that the city with the earlier start time had 4.5 times the number of teen crashes compared to the city with a one hour later high school start time (Vorona et al. 2011). More recently in 2014, Vorona et al. compared two adjacent, demographically and geographically similar counties in Virginia: Henrico and Chesterfield. Crash rates were again higher in the county with an earlier school start time (Chesterfield County at 7:20 am, Henrico at 8:45 am). Building off this research, the author proposed **Hypothesis 3a and 3b that earlier class start times would positively correlate with the number of self-reported driving errors, and not correlate with number of self-reported violations**.

College Students vs. High School Students

Throughout this literature review the author has focused on teenagers and high school students when discussing school start times. The population for the current study however came exclusively from college undergraduates. With sleepiness, the author believes that college freshman and sophomores, who are often still teenagers and are away from parents in a new setting, would have patterns of sleepiness similar to that of high school seniors. The study will look at whether the same detriments of sleepiness and school start times that are seen in high school students carry over to teen college students. This is a previously under-explored area of research. Thus, the author proposed **Hypothesis 4: teen college students (i.e., those 18 and 19 years old) would report higher levels of sleepiness, and in turn higher numbers of driving errors than college students 20 years old and older.**

Hypotheses

The author hypothesized a partial mediated model, such that self-reported sleepiness would mediate the positive relationship between early class start times, and higher amounts of self-reported driving errors (see Figure 1). The same model was tested for driver violations with the expectation no relationships would exist (see Figure 2). The hypotheses building these model tests are summarized here.

Hypothesis 1a (Figure 1, Path A): Higher levels of sleepiness would positively correlate with the number of self-reported driving errors (increase errors)

Hypothesis 1b (Figure 2, Path A): Sleepiness would not significantly correlate with the number of self-reported violations.

Hypothesis 2 (Figures 1 and 2, Path B): Earlier class start times would positively affect sleepiness (increased sleepiness).

Hypothesis 3a (Figure 1, Path C): Earlier class start times would positively correlate with self-reported driving errors (increase errors).

Hypothesis 3b (Figure 2, Path C): Earlier class start times would not correlate with self-reported violations.

Hypothesis 4a (Figure 1): There would be a significant difference between teenage college students, and their older counterparts, such that teenagers would report higher levels of sleepiness, and in turn higher instances of driving errors.

Hypothesis 4b (Figure 2): There would not be a significant difference between teenage college students, and their older counterparts, such that teenagers would not report higher levels of sleepiness, and in turn higher instances of driving violations.

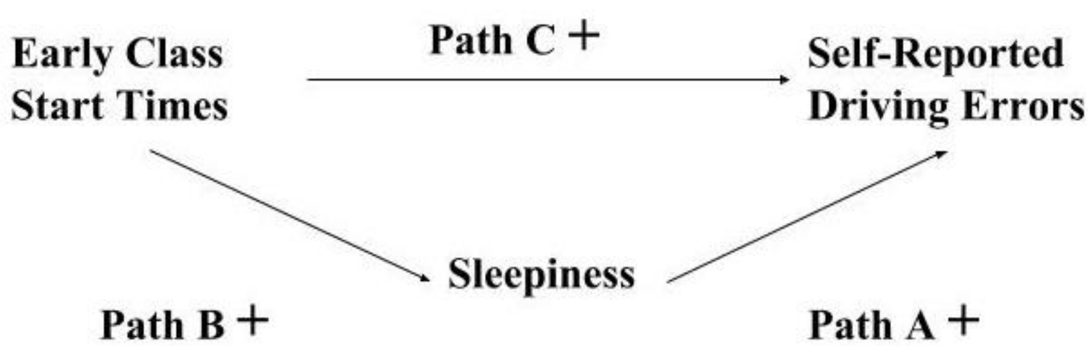

Figure 1. Hypothesized partial mediation model of relationships among early school start times, sleepiness, and driving errors.

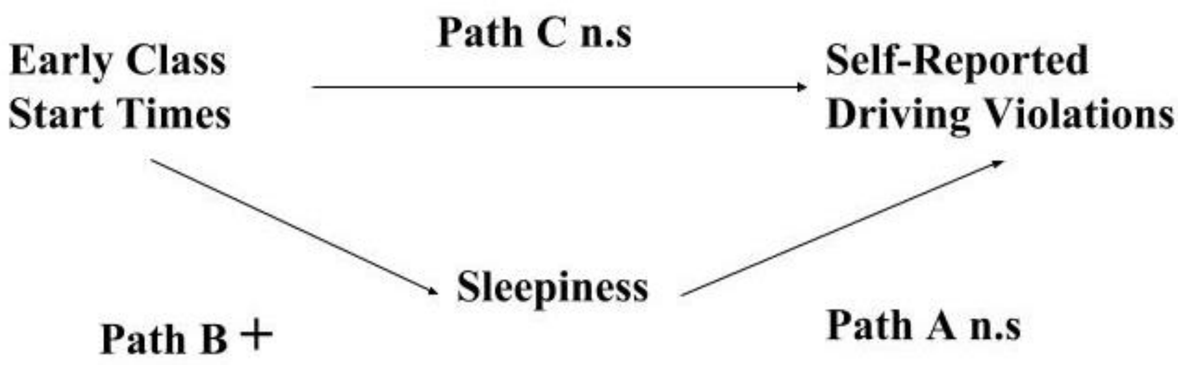

Figure 2. Hypothesized non-significant relationships among school start times, sleepiness, and driving violations.

CHAPTER 2

METHOD

Participants

A sample of undergraduate students from Old Dominion University was used for this study. Power analysis for Pearson *r* correlations indicated that with an alpha of .05, power of .80, and an effect size of .02 (based on pilot data), 150 students were required. (G*Power; Faul, Erdfelder, Buchner, & Lang, 2009). Since mediation and moderated were also tested, the author aimed for a minimum of 300 students. Participants were recruited through SONA, an online Research Participation System used by the University's Psychology Department. Based on pilot data, the author expected a 70/30 ratio of females to males. Because there may be differences in male and female's sleeping patterns/behaviors, procedures were put in place to ensure a closer to equal sample size (see Procedures). Regardless of gender, to be eligible to complete this study, participants were required to be 18 years old or older, hold a valid driver's license, and be enrolled in a psychology course. All participants who completed the study were awarded one participation credit toward a class requirement. This study was reviewed and approved by the appropriate University's Institutional Review Board.

Measures

The main variables of interest were: school start times, sleepiness, driving errors, and driving violations. School start times were provided by responses on demographic questions. Sleepiness was estimated with two different measures: the Epworth Sleepiness Scale (ESS), and the Pittsburgh Sleep Quality Index (PSQI). Driving Errors and Violations were assessed by the Driving Behavior Questionnaire (DBQ).

Other covariates of interest included sensation seeking, which was measured using the Sensation Seeking Scale Version 5 (SSS). Sensation seeking has commonly been linked to aggressive driving and is a recognized covariate of driving risk. Gender, age (dichotomized as 18 and 19 vs. older), and driving experience (miles driven per week) were also used as covariates. Below the author discusses the variables in more depth before moving on to the procedure.

Epworth Sleepiness Scale (ESS) (Johns, 1991). The ESS is a measure of a person's general level of daytime sleepiness. The measure asks participants to rate on a scale of 0 (*would never doze*) to 3 (*high chance of dozing*) their chance of dozing in each of eight situations. Example questions are as follows: "Sitting and reading," "Watching TV," and "In a car while stopped for a few minutes in the traffic" (see Appendix A). The eight ratings are summed to form the ESS score. Higher scores indicate more sleepiness, with normal healthy adults scoring between 0-10. The ESS showed good internal consistency ($\alpha = .735$). Smolley, Ivey, Farkas, Faucette, and Murphy (1993), as well as Johns (1992, 1994), have demonstrated the construct and concurrent validity of the ESS. They compared participants' scores on the ESS to their mean sleep latency in the Multiple Sleep Latency Test (e.g. rho = -.042, n= 44, $p < .01$). Scores were related in that the higher a person scored on the ESS, the lower they scored on the MSLT, indicating sleepiness. The Multiple Sleep Latency Test is the standard clinical physiological measure of sleepiness developed by the Association of Sleep Disorders Centers Task Force on Daytime Sleepiness (Carskadon et al., 1986). The MSLT is performed in a lab, and only measures sleep behavior on one sitting. Comparing the ESS to the MSLT, it is beneficial to use the ESS because it accounts for multiple daily situations, rather than just one night's sleep, and is easily administered.

Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, (1989). The PSQI is an instrument used to measure the quality and patterns of sleep in adults. Because there is no set "sleepiness measure," the author decided to add the PSQI as another measure of sleep. As mentioned above, the Epworth's Sleepiness Scale only measures daytime sleepiness. While daytime sleepiness is commonly related to sleeping habits, the author also wanted to consider quality of their sleep. The PSQI differentiates "poor" from "good" sleep by measuring seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. There are nineteen total questions. Participants rate each of these seven areas based on their sleep over the past month. Scoring is based on a 0 to 3 scale, where 3 reflects the negative extreme on a Likert Scale. A global sum of 5 or greater indicates a "poor" sleeper (see Appendix B).

The PSQI had acceptable reliability with internal consistency for the seven components with an overall α=.59. This means that each of the seven constructs measured a particular aspect of the same overall construct which is sleep quality (Buysse et al., 1989). Backhaus and colleagues (2002) also showed that the PSQI has excellent test-retest validity (r=.87, p<.001). Finally, in 2008, Buysse and colleagues, reported the ESS and PSQI shared less than 3% of the variance between them (r=.16, p=.03). Thus, ESS and PSQI measure two different unique dimensions of sleep-wake experience with ESS assessing daytime sleepiness and PSQI measuring sleep quality

Driving Behavior Questionnaire (DBQ) (Reimer et al., 2005). The DBQ is a 24-item questionnaire that assesses risky driving behaviors in three categories: (a) errors - the failure of planned actions to go according to plan which may result in potentially dangerous outcomes (i.e. failing to stop at a stop sign); (b) violations – deliberately driving in a hazardous way that the driver knows may not be safe (i.e. aggressive driving); and (c) lapses – attention and memory failures that can be embarrassing, but do not usually have an impact on driving safely (i.e. forgetting where one parked the car). Although the entire DBQ was administered, only the error and violation subscales were used in the analyses. Errors was the author's main focus for this study, and was what previous research suggested would be affected by sleepiness (Reimer et al., 2005). Violations on the other hand was used as a comparison outcome that was not expected to be affected by start time and sleepiness.

Questions were scored on a Likert-type scale ranging from 0 (*never*) to 5 (*nearly all the time*). Higher scores on each subscale represented higher reported frequencies of the behavior (errors, violations, and lapses). An example question measuring errors is "Try to pass another car that is signaling a left turn." "Drive very close to a car in front of you as a signal that they should go faster or get out of the way" would be an example of a question measuring violations (see Appendix C). The DBQ has high internal consistency overall, α=.84. As for construct validity, previous studies have shown via factor analysis that the subscales are adequate in discriminating among self-reported driver risk-taking behaviors, particularly in the three-factor model of Errors, Violations, and Lapses (Lajunen et al., 2004; Parker et al., 2000; Reason et al, 1990).

Sensation Seeking Scale - Form V (SSS-V) (Zuckerman, 1996). The SSS-V measures various sensation seeking behaviors. It is comprised of four 10-item subscales: Thrill and Adventure Seeking (TAS); Experience Seeking (ES); Boredom Susceptibility (BS); and Disinhibition (DIS). Each item is composed of two different anchors from which participants must choose the best description of how they feel; this is a forced choice agreement scale. For example, "I like 'wild' uninhibited parties" versus "I prefer quiet parties with good conversation"(see Appendix D). The TAS subscale measures involvement in risky sports and 60 adventurous physical activities like rock climbing or parachuting; the ES subscale measures engagement in music, art, travel, and drugs; the DIS subscale measures social extraversion and impulsive behaviors through sexual experiences, drinking, and parties; and the BS subscale measures intolerance of repetitive experiences (Zuckerman, 1996). The Total Score provides an overall assessment of sensation seeking. Internal consistency is acceptable for the overall measure, α=.64.

Demographic questionnaire. Participants completed a detailed demographic questionnaire to collect information about: age, gender, driving experience (both length of licensure and average weekly miles of driving), traffic crash information (including crashes related to sleepiness), earliest class start time for each day of the week, obligations before class, whether they commute, and if so, information about that commute, and average daily amount of sleep (in hours) (see Appendix E).

Procedure

This study was available online through the department's SONA system. Psychology students from the subject pool were recruited to participate in the study. The author decided to ensure an equal sample size of men and women by creating two separate studies for each that were available on SONA. The survey was exactly the same for men and women with the only difference being the author could control how many of each gender could enroll in the study (to attempt equal n in gender). Participants were offered one credit upon completion of the study to be used toward course requirements in psychology. After signing up for the study, students received a link to take the survey online via Qualtrics.

First, participants read a brief overview of the nature and purpose of the study (Information Sheet; see Appendix F). Next, they filled out the Epworth Sleepiness Scale, Pittsburgh Sleep Quality Index, Driving Behavior Questionnaire, and Sensation Seeking Scale (the order of the four was randomized), and finally the demographic questions. After they completed the survey they were presented with a completion / thank you page, and exited the survey to a separate survey link to enter information for course credit to ensure data were not linked to identifying information. In total, the procedure required fewer than 60 minutes to complete.

CHAPTER 3

RESULTS

Data Preparation

A total of 569 students participated in the survey, well surpassing the minimum expected number of 300 to complete the mediation models. Of these, 63 did not have an on-campus class and were most likely online students. These participants were excluded from data analysis. Of the 506 remaining, 360 were female (146 male; i.e., efforts to have equal gender numbers were not successful), a little less than half were of commuter status (n=235, 46.6%), and there was mostly an even split among the four class years (Freshman to Senior). Finally, Age and Miles Driven per Week had fewer responses than the other three main demographic variables. Finally, DBQ subscales, Errors (*M*=13.99, *SD*=4.99), Lapses (*M*=15.33, *SD*=5.16) and Violations (*M*=17.42, *SD*=6.45) had a good range of responses, and did not indicate ceiling effects. Descriptive statistics are included in the Table 1.

Table 1. *Descriptive Statistics*

	N (%)	Mean	SD
Age	460	22.6	6.92
Class Year	505		
Freshman	126 (24.9)		
Sophomore	92 (18.2)		
Junior	142 (28.1)		
Senior	145 (38.7)		
Sex	506		
Male	146 (28.9)		
Female	360 (71.1)		
Commuter Status	504		
Yes	235 (46.6)		
No	269 (53.4)		
Miles Driven in Past Week	417	126.16	174.65

Composite scores were created for the DBQ (Errors, and Violations), SSS by summing the item scores. The PSQI composite scores (Buysse et al., 1989) were created by summing item questions, and re-coding them into 0-3 component scores (coding details can be found in Appendix A). The seven component (subscale) scores were then summed to create the Global PSQI Score.

The Early Class Start variable was created by dichotomizing the answer to the question "When is your earliest class start time for each day of the week?". Those who had at least one 8 am class were coded as yes (1; n=152, 30%), and those who did not have any were coded as no (0; n=354, 70%).

The Age variable was created by dichotomizing the ages into an 18-19 (teenage) group, and older than 19 group. This variable was dichotomized in preparation for the moderation model. However, this version of the variable was also used in all other models as a covariate.

Next, the author assessed the data for normality. Skewness and kurtosis were examined for all variables via the skewness and kurtosis option in SPSS descriptive variable section (SPSS Inc., 2009). All variables of interest but two had a skewness statistic less than 3, and kurtosis statistic less than 20, indicating the data were not skewed or kurtotic (Mardia, 1974). The two exceptions were Miles Driven per Week, and PSQI. The author tested all models with transformed versions of these variables. The author then tested the same models with the untransformed variables. None of the relationships among variables changed when using the untransformed versions. Therefore, the author reported the models with the untransformed variables for clarity.

Correlations

Both Pearson product-moment and point bi-serial correlations were calculated to assess the relationships between the variable pairs (see Table 2). As expected, higher ESS scores (more sleepiness) positively and significantly correlated with PSQI (more sleep dysfunction), Early Class Start (having at least one class start at 8am), commuter status (being a commuter), reported Driving Errors (more reported errors), and Sensation Seeking (higher scores). Unexpectedly, ESS also correlated positively and significantly with Violations (more violations) and Lapses (more lapses). In contrast, PSQI only significantly correlated with ESS, Violations, and Lapses. Having at least one early class was significantly and negatively associated with age (younger), class year (more likely to be freshman or sophomore vs. junior or senior), and weekly miles driven (fewer miles on average). For the driving variables, in addition to their correlations with

ESS or PSQI, Errors and Violations were negatively and significantly correlated with Age (younger), and positively and significantly correlated with commuter status (more likely to be commuter) and SS (more likely to be sensation seeking). It is interesting to note that among our driving behavior variables (errors, lapses, and violations), intercorrelations were high. Among the three subscales, they shared 27%-46% of the variance. So, although these concepts are different from one another they are also highly related, and it may be difficult to tease out differences.

Table 2. *Pearson Correlation Matrix*

	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	---											
2. Sex	.066	---										
3. Class Year	.709**	.128**	---									
4. Commuter Status	.23**	.014	.101*	---								
5. Miles Driven in Past Week	.177**	.046	.082	.320**	---							
6. Early Class Start	-.207**	.027	-.253**	-.012	-.120*	---						
7. ESS	-.005	.040	-.047	.089	.047	.125**	---					
8. PSQI	.033	.029	.023	.055	.074	-.056	.208**	---				
9. Violations	.086	-.013	.038	.122**	.114*	-.042	.276**	.135**	---			
10. Errors	.026	-.005	-.003	.099*	.019	.009	.212**	.080	.666**	---		
11. Lapses	.038	.065	.000	.012	.019	-.005	.267**	.130**	.520**	.736**	---	
12. Sensation Seeking	.056	-.135**	-.036	-.022	.070	-.038	.117*	.068	.314**	.204**	.213**	---

Note. Age (18 & 19, >19), Early Class Start, and Commuter Status were measured dichotomously. Violations, Errors and Lapses are subscales of the Driving Behavior Questionnaire. Reported Pearson's r's are raw, and not corrected for alpha inflation.
* $p < .05$. ** $p < .01$.

Model and Hypothesis Testing

Path analyses were conducted using the PROCESS Macro, developed by Hayes (2012), to examine the effects having an 8 am class start time had on driving behaviors. The author hypothesized a mediated model, with sleepiness measured by ESS and PSQI as mediators between start time and driving behavior.

Hypothesis 1a. Higher levels of sleepiness would positively correlate with the number of self-reported driving errors (increase errors). As previously explained, two measures were used to get a more complete view of sleepiness; the ESS and PSQI. As expected, the correlation between ESS, and Errors was significant (r = .212, p< .001) (see Figure 3). That is, higher scores on the ESS (more daytime sleepiness) were associated with higher reported numbers of driving errors. In contrast, PSQI did not correlate with self-reported errors (r=.08, p=.116). Possible reasons for PSQI not correlating with Errors will be offered in the discussion.

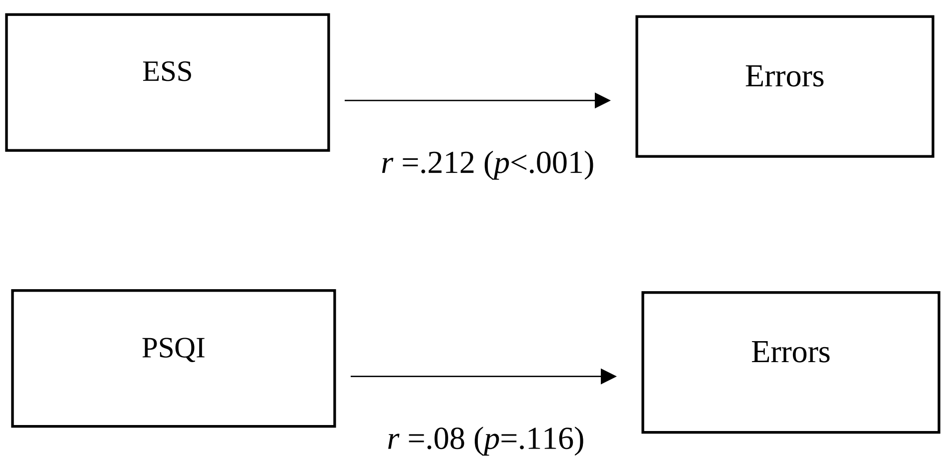

Figure 3. *Correlations between Sleepiness Variables and Errors*

Hypothesis 1b. Higher levels of sleepiness would not significantly correlate with the number of self-reported violations. This hypothesis was not supported as correlations between both ESS (r = .276, p< .001) and PSQI (r=.135, p<.001) and violations were significant (see Figure 4). Higher scores on the ESS (more daytime sleepiness) and PSQI (more sleep dysfunction, lower quality) were associated with higher reported numbers of driving violations.

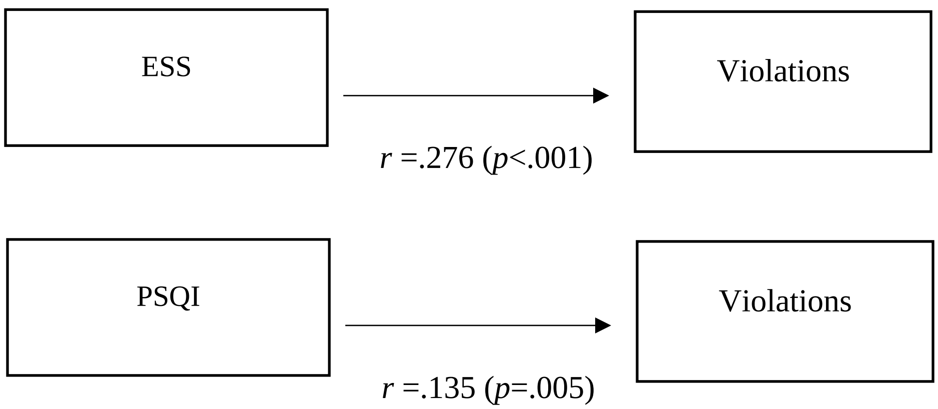

Figure 4. *Correlations between Sleepiness Variables and Violations*

Hypothesis 2. Earlier class start times were expected to positively affect sleepiness (increased sleepiness). As expected, the point biserial correlation between earlier class start time (having an 8 am class or not) and ESS was significant (r_{pb} = .125, p< .001) (see Figure 5). Early Class Start was associated with higher scores on the ESS (more daytime sleepiness). PSQI, again, did not correlate with Early Class Start (r_{pb} = -.086, p=.261).

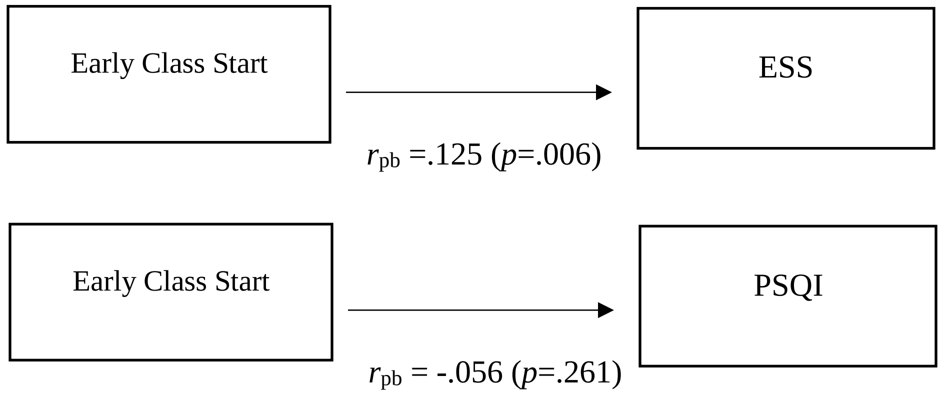

Figure 5. *Correlations between Early Class Start and Sleepiness variables*

Hypothesis 3a and 3b. Earlier class start times were expected to positively correlate with self-reported driving errors (increase errors) and violations. Point biserial correlations between earlier class start time (having an 8 am class or not), and errors were significant (r_{pb} = .125, p=.006), while violations were nonsignificant and (r_{pb} = -.056, p = .261).

Finally, because correlations indicated that there might be relationships among earlier class start times, daytime sleepiness, and errors/violations, the author continued with testing the main hypothesis which was, if the correlations show these variables to be related to each other, a mediation model might be an applicable, multivariate and parsimonious representation of the overall relationship. The PROCESS Macro, developed by Hayes (2012), was used to test the paths.

> "PROCESS uses an ordinary least squares or logistic regression-based path analytic framework for estimating direct and indirect effects in single and multiple mediator models and (…) indirect effects of interactions in mediated moderation models also with a single or multiple mediators. Bootstrap and Monte Carlo confidence intervals are implemented for inference about indirect effects, including various measures of effect size." (Hayes, 2012).

For this study's purposes, Model 4 was used (see Figure 6) and 10,000 bootstrap samples were pulled. Additionally, the author controlled for the effects of dichotomous age, sex, miles per week driven and composite sensation seeking. One last comment on model preparation: the author tested whether the model would vary for commuters vs. everyone. The results did not change; therefore the author ran the model with all participants.

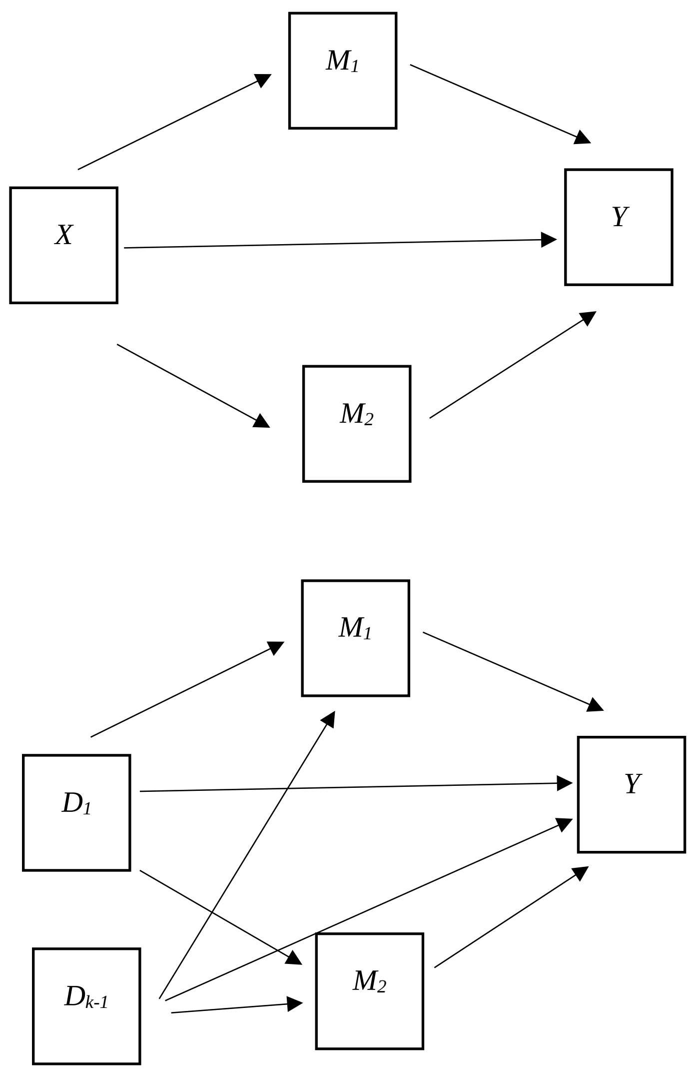

Figure 6. *Model 4 Conceptual and Statistical Diagrams (Hayes, 2012)*

Path analysis results are displayed below in Figures 7 and 8. Early class start time was positively associated with ESS (B = 1.25, *p*= .0175), and ESS in turn was positively associated with self-reported errors (B = .1431, *p*= .0289). Early class start time was not significantly associated with its direct path for self-reported errors (B = -.5553, *p* = .3212). Although the direct effect of having an 8 am class start time was not associated with self-reported errors, the indirect effect was significant, *ab* = .1790, CI (.0257, .4865) (see Figure 7). A significant indirect effect in the absence of a direct effect indicates that ESS fully mediated the relationship between having an 8 am class start time and self-reported driving errors.

Although Hypothesis 3a was supported, Hypothesis 3b was only partially supported. Similar results revealed early class start time was positively associated with ESS (B = 1.0313, *p*< .001), and ESS in turn was positively associated with self-reported violations (B = .2596, *p*<.001). Early class start time was not significantly associated with self-reported violations (B = -1.4016, *p* = .0761). Again, although the direct effect was not significant the indirect effect of early class start was significant, *ab* = .2677, CI (.0149, .7022) (see Figure 8). A significant indirect effect, without any direct effect, indicates that ESS fully mediated the relationship between having an early class start time, and self-reported driving violations.

Although these results were found for ESS, the other measure of sleepiness, PSQI, did not have a single significant pathway in both the errors and violations models. For these reasons, PSQI was removed from the models, and the models were re-calculated (see Figures 9 and 10). PSQI was also not included in any future models. The new parsimonious models continued to show the same mediated relationships for Errors *ab* = .1898, CI (.0296, .4727) and Violations *ab* = .3329, CI (.0443, .7650) The PSQI and ESS appear to measure different aspects of the sleep-wake experience. Suggestions for why these aspects would affect driving behavior differently are discussed.

Finally, although age, sex, miles driven, and sensation seeking were used as covariates, on both the mediators and class start time, only sensation seeking was significantly correlated with errors (B = .0045, $p<.001$) and violations (B = .2726, $p<.001$). This relationship was expected based on previous literature. This relationship and those with other covariates were left out of the figures for parsimonious reasons. However, all covariates were maintained in all models for theoretical consistency with other literature, not solely because of significant relationships or the lack thereof.

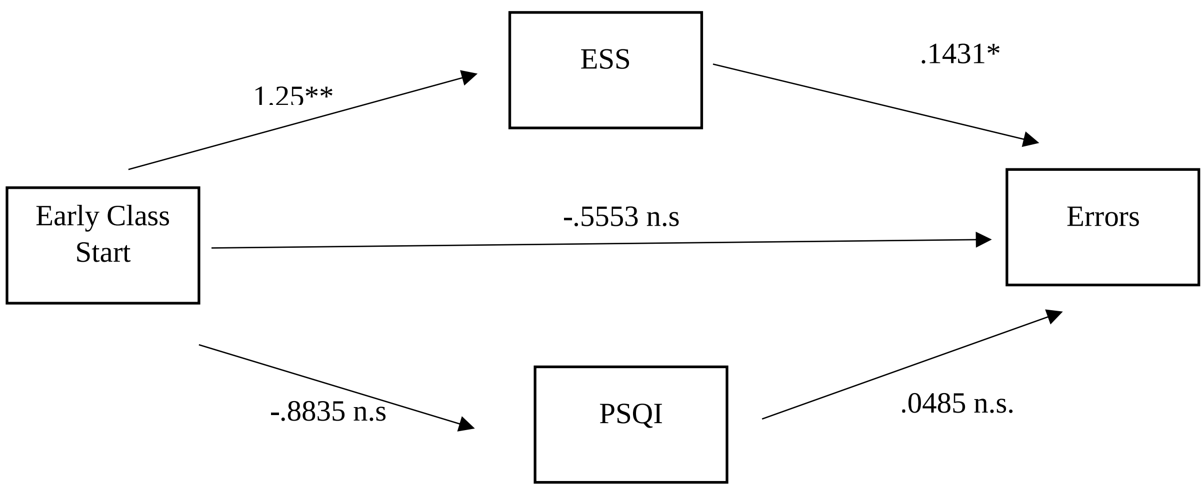

Figure 7. *Path Coefficients between Class Start Time, ESS, PSQI and Errors*

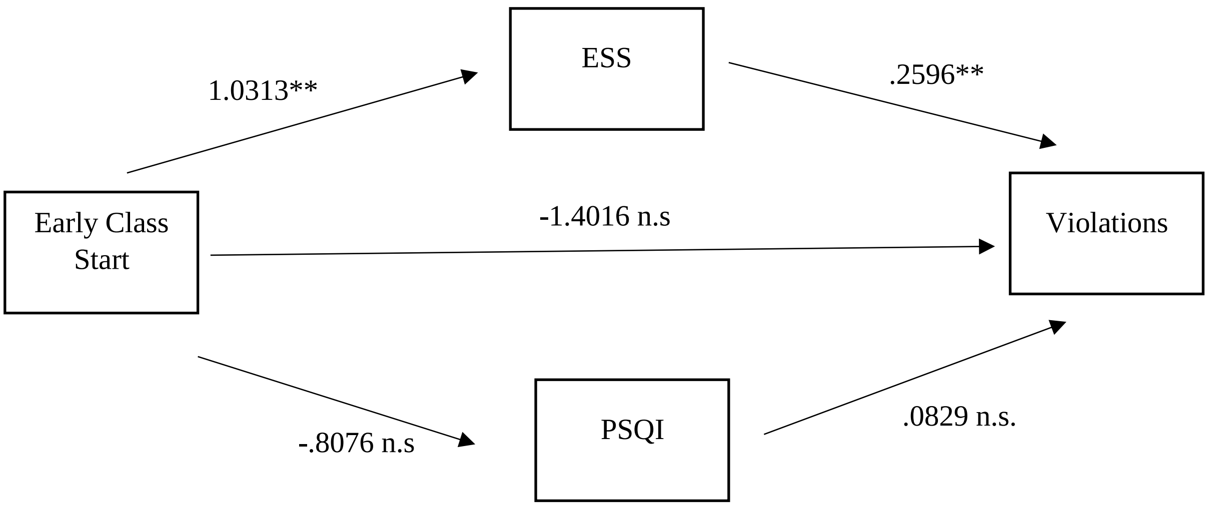

Figure 8. *Path Coefficients between Class Start Time, ESS, PSQI, and Violations*

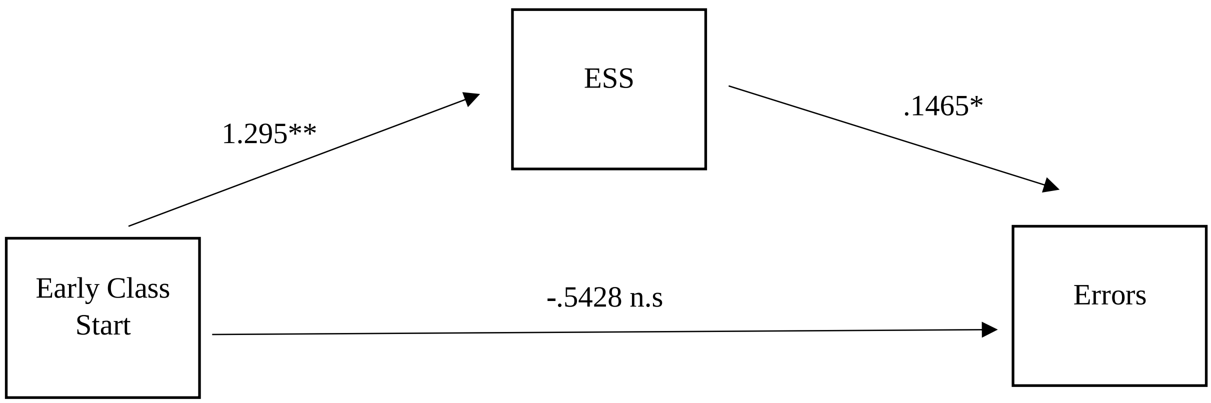

Figure 9. *Path Coefficients excluding PSQI from the model (Errors)*

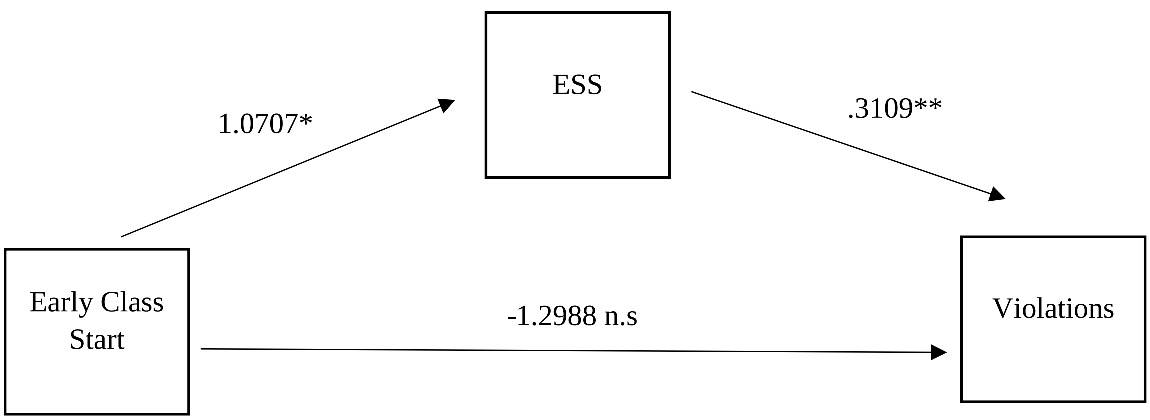

Figure 10. *Path Coefficients excluding PSQI from the model (Violations)*

Hypothesis 4. There would be a significant difference between teenage college students and their older counterparts on reported levels of sleepiness and then in turn on driving errors To test this hypothesis the author ran a moderated, mediated path analysis (Model 7, see Figure 11). The mediated model was the same as in earlier models, however, the dichotomized age variable was removed as a covariate to be a moderator of start time on the ESS pathway.

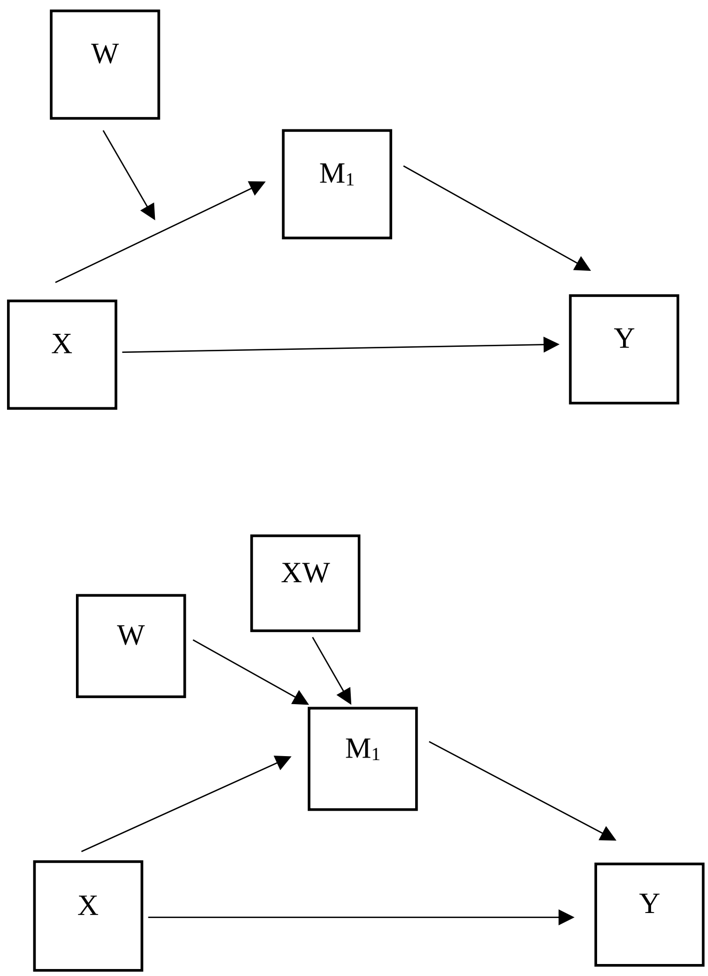

Figure 11. *Model 7 Moderated Mediated Conceptual and Statistical Diagrams (Hayes, 2012)*

Results revealed that this hypothesis was not supported (see Figures 12 and 13). Age did not moderate the relationship between 8 am class and ESS in both the errors (B = .5626, p=.6081) and violations' (B = .2280, p=.8348) models.

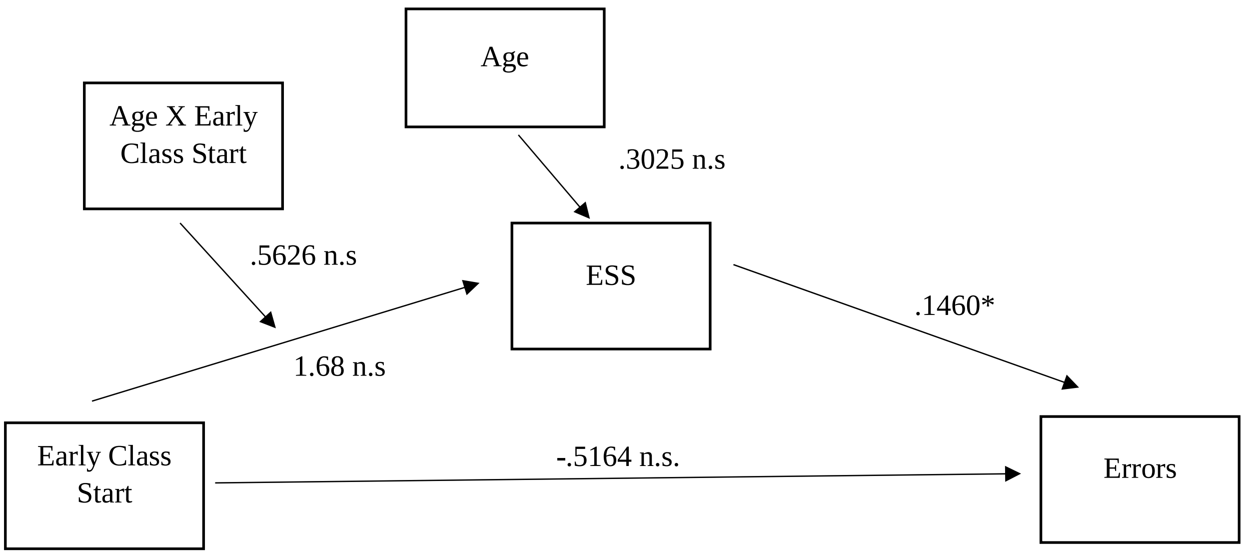

Figure 12. *Age Moderation – ESS Mediation, (Errors), Statistical Model*

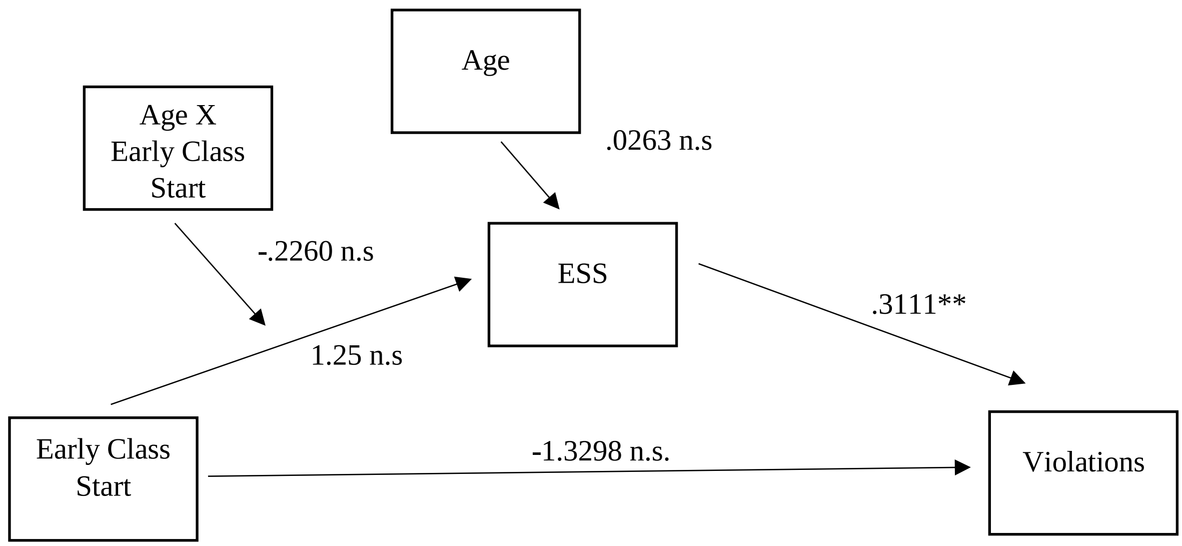

Figure 13. *Age Moderation – ESS Mediation, (Violations), Statistical Model*

Exploratory Analysis:

Commuter status has not previously been discussed in the literature regarding sleepiness, early class start times, and driving behaviors, but was thought to be an important variable in these relationships (correlations revealed commuter status to be significantly correlated with ESS, Errors, and Violations). The author tested a second moderated mediated model to explore these potential relationships. In these models, the dichotomized commuter status variable was used as the moderator between the 8am class and ESS pathway in both the errors and violations models. Path analysis results show that commuter status did not moderate the effect of 8 am class on ESS in either the errors (B = -1.70, p=.0889) or the violations' (B = -1.3267, p=.1888) models (see Figures 14 and 15).

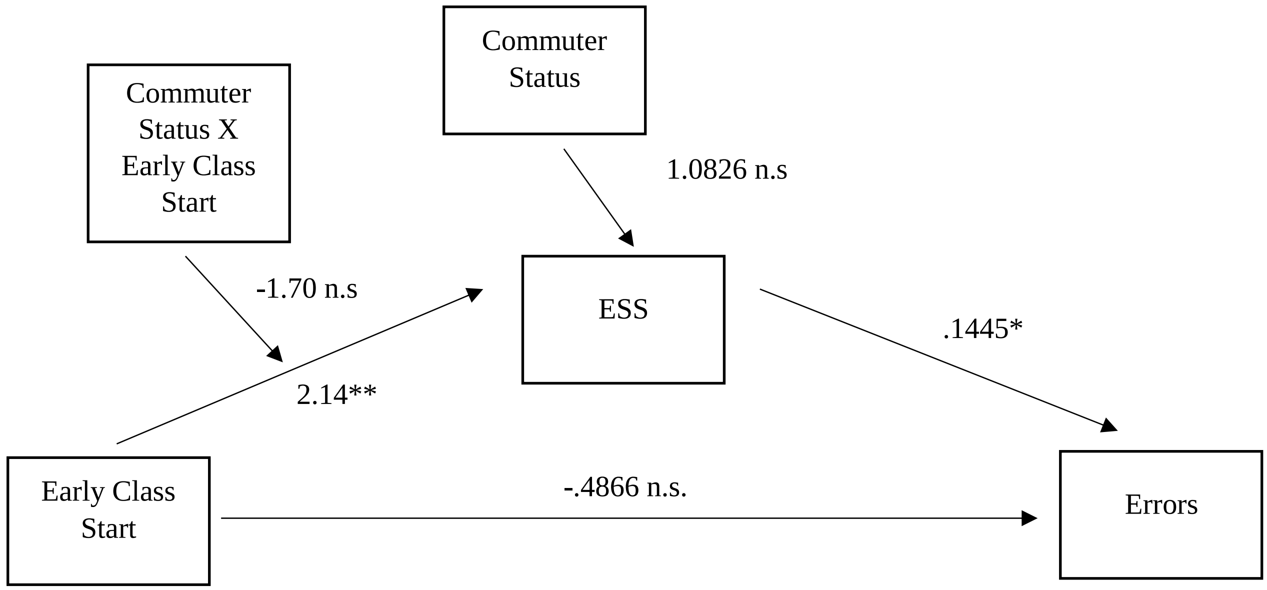

Figure 14. *Commuter Status Moderation-ESS Mediation, (Errors), Statistical Model*

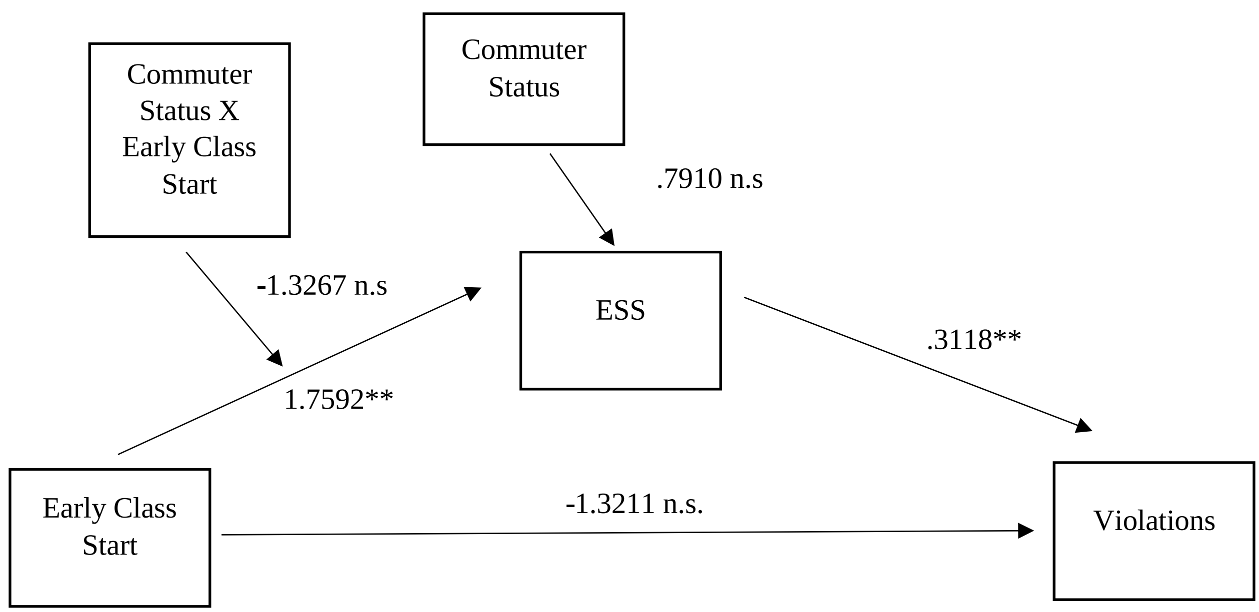

Figure 15. *Commuter Status Moderation-ESS Mediation, (Violations), Statistical Model*

CHAPTER 4

DISCUSSION

The author's study sought to understand the relationship among driving behaviors, sleepiness, and college class start times, and support the theoretical model that sleepiness is higher in students who have earlier class start times. The results indicated that there are similar relationships among these variables as have been seen in high school populations and provide general, overall support for major theoretical expectations. Specifically, class start times correlated with driving behaviors via mediation by sleepiness. School start times are likely affecting duration of sleep, and this sleepiness is the leading factor to driving risk. Interestingly, the sleepiness that mattered here was daytime sleepiness, not sleep quality. This finding and others of note are further discussed below, but do provide support for the overall expectation that school start times and sleep affect driving for college students.

PSQI vs. ESS

In the study, the author ran the proposed models with both the ESS and PSQI representing sleepiness. Interestingly, PSQI only correlated with Violations, not Errors, and when added to the model did not significantly predict a single variable. In comparison, ESS fully mediated the relationship between class start time, and driving behaviors (both Errors and Violations).

Previous research by Buyesse et al (2008) found that the PSQI and ESS are two orthogonal measures of the sleep-wake system. Why then would ESS (daytime sleepiness) matter and not PSQI (sleep quality)? One possible explanation is that PSQI was related to “hyperarousal” (Buyesse et al, 2008). Hyperarousal is defined as an abnormal increased responsiveness to stimuli and has been linked to insomnia’s pathophysiology. The author thought that the symptoms of impaired sleep quality, depression, anxiety, and stress may be linked through this “hyperarousal.” Daytime sleepiness, however, may be unattached to hyperarousal and the negative outcomes associated with it (e.g., anxiety), as daytime sleepiness is associated with decreased vigilance, the opposite of hyperarousal (Strohl, et al. 2015). Perhaps school start times only impact sleepiness via reducing hours of sleep, not necessarily directly affecting other components in sleep quality.

Overall, the differences between ESS and PSQI may not be fully explained with this study’s data. Future research may wish to consider more thorough investigation of daytime vs. quality components in sleep relationships to driving.

Errors and Violations

Besides ESS being the sole significant mediator between school start time and driving behavior (and not PSQI), another unexpected finding from the author’s study was that both the Errors and Violations’ models were significant. The author proposes two reasons why both Errors and Violations were significant. First, intercorrelations among the driving variables were high. In some cases, they shared 46% of the variance. This indicates that the variables are highly related to one another even if they are different constructs. Due to this, it may be hard to tease out the differences between the two.

Second, the author previously hypothesized that sleepiness would only effect Errors due to the cognitive deficits that sleepiness produces. The author’s explanation for why violations correlate with daytime sleepiness, and indirectly early class start times, is that daytime sleepiness causes changes in a student's mood. Research supports this explanation. Students who fell asleep in school reported higher negative mood states (Jean-Louis et al, 1998). Intentionally sleep-deprived students also showed decreased mood (Lo et al, 2016). In two separate studies, sleepy college students reported increased anxiety, depression, and anger, (Dinges et al, 1997; Pilcher et al, 1997). Finally, in a 2002 poll by the National Sleep Foundation, 64% of participants reported getting impatient/aggravated when waiting in line, when traffic is backed up, or when others were late for an event or meeting (NSF, 2002).

When considering driving behaviors, traditional definitions indicate errors are more the result of honest mistakes, while violations are committed with intent. We are all familiar with people being described as "grumpy" in the morning, or irritated. Aggressive violations (rather than ordinary violations) also have an emotional/interpersonal component to them which makes it plausible that being more irritated, or emotional (due to lack of sleep from early mornings), would also increase your intent to drive recklessly and make violations. Further, in the driving literature, those who self-reported being angry were more likely to drive faster than the speed limit (one of the violations measured by the DBQ) (Mesken et al., 2007). Deffenbacher and colleagues (2001) also indicated that there was a substantial difference in likelihood to engage in aggressive behavior while driving, when comparing high-anger and low-anger drivers. High-anger drivers were 3.5-4.0 times more likely, while low-anger drivers were only 1.5-2.0 likely to engage in aggressive driving. The literature provides support for the author's explanation that the relationship between sleep and mood, and driving and mood, is a plausible one for why violations were significant in the model. Mood directly assessed may be an important variable for future inclusion in this line of research.

The Lack of a Relationship between Commuter Status and Age

As the exploratory analysis indicates, commuter status did not affect the relationship among early class start times, sleepiness, and driving behaviors. The author had previously thought that this would be an important moderator. This was expected because being a commuter may necessitate waking up earlier than when living on campus (to account for extra travel time), which could have, possibly, worsened sleepiness effects on driving. Additionally, the author thought that commuter status might influence which classes a student chose. For example, knowing that one has additional travel time, one might not sign up for early classes. However, it seems on both accounts commuter status did not matter in this sample. There were roughly equal enrollments in 8 am class between commuters and non-commuters, and the effects of early class start time were not significantly worse for commuters. The author tentatively suggests that driving earlier may not be the central component; rather the interplay between early class start time and how sleepiness is impacted is probably more important.

Commuter status did not affect these relationships, and surprisingly age (dichotomized into 18 and 19 vs. other) was also not a factor. Again, the author had expected age to be important because younger individuals have less driving experience, cognitive developments, and additional sleep issues. For traditional-aged college students in particular, the transition to college from high school was not expected to erase start time and sleepiness impacts on behavior. In light of the results, one could expect that we are all at risk for sleepy driving equally – at least once we leave high school. Previous research which has focused on shift workers and truck drivers has found support for how sleepiness impacts on adult driving (Åkerstedt, 2003; Drake et al., 2004; and Howard et al, 2003). Articles focused on these issues have overwhelmingly supported sleepiness as an important issue for not only teens, but adults as well.

Some concerns with mandating later school start times suggest that eventually teens will more than likely be in a 9-5 job at some point in their life. The argument is that teens will need to adjust to this earlier schedule to function in our society. However, an interesting question would be whether 8 or 9 am start times for any type of work may be detrimental, especially in our current discussion of driving behaviors. We live in a mainly early-riser society. Although this question may be out of the scope of this study, the author believes it may be beneficial to ask "Should society be on this early schedule, at any age?" Research already supports that even for adults, schedules should be modified to fit their specific chronotype (earlier riser, late riser and in-between) (Wittmann, 2006). So why does society continue to enforce an early riser norm, that may in fact be an unhealthy norm?

Limitations of the Study

This study had several limitations. The cross-sectional design meant participants filled out the survey once, and reported behaviors at that current time. This limited the analysis to only what the students were feeling or doing that day, and their current age. The ESS survey design also limited the analysis. It asked participants about sleepiness over the past week, therefore the author could not get daily reports on daytime sleepiness, only a lump weekly sum. Second, every single variable measured relied on self-reported data. Research has also shown that driving behavior can estimate and in some cases predict crash risk, which is why the author, (along with its feasibility) used self-report (Elander, West, & French, 1993). However, self-report data are at-risk for biases from social desirability or inconsistent/poor recall. There are several measures for both sleep and driving behaviors that do not rely on self-report, however none were realistically available for this study. For example, sleep studies (such as the MSLT) are effective for measuring actual sleep patterns. Driving simulators could be helpful in obtaining objective driver measures such as EEG measurements (Risser & Ware, 1999), or seeing the effects of sleepiness in a controlled environment (Davenne et al. 2012). The author would caution though, that although self-report has its own limitations, these other measures via sleep studies or simulation may not perfectly reflect sleepiness or driving behavior outside of a lab (Reynolds et al. 1992; Riedel et al. 1998).

Future Directions

Future directions could include conducting a prospective, longitudinal design. Collecting data over multiple time periods has benefits. First, if a student were to have an 8 am class one semester, and not have one the following semester (and vice versa), differences in sleep patterns and driving behaviors during these times might further support the role these start times have on sleepiness impacts. Second, if a longitudinal study was conducted first with high schoolers and followed those students into and through college, researchers could see further evidence of early class start times being an issue regardless of age. However, realistically, longitudinal designs in this field are rare given the expense required and the logistical difficulties in following students from high school into college.

In addition to methodological changes, there are still questions from this study that need clarifying. Chiefly, what is the difference among sleepiness, fatigue, and sleep quality? For example, why does daytime sleepiness predict driving behavior, but not quality of sleep (as measured by the scales used here)? Should fatigue and sleepiness be used interchangeably as has often been done in the literature, or are they unique constructs?

Further questions might also focus on sleep quantity. Many studies (Boergers, Gabel, & Owens, 2014, Danner & Phillips, 2008; and Onyper, Thacher, Gilbert, & Gradess, 2012) report gained hours of sleep from later school start times, or conversely, a lack of sleep indicating sleep deficits. Why do such studies focus on quantity of sleep as an important predictor? Which is the better predictor of driving behaviors, daytime sleepiness, sleep quantity, or sleep quality? These are all excellent next steps for the literature regarding this subject, and can help better explain the findings of the current study.

Implications for the Future

Recently, NPR circulated an article entitled “Down With 8 A.M. Classes: Undergrads Learn Better Later In The Day, Study Finds” (Sarwar, 2017). The piece discusses how undergraduates were learning better later in the day and advised students to not take 8 am classes. NPR’s focus on this issue has brought it into the national conversation. More professionals are becoming aware of the issues with early class start times. The NPR article made many of the same arguments this thesis has: that biological changes in students create serious changes in sleep habits, necessitating a later start – not out of a student’s laziness, but from a pure biological need. The results from this thesis indicate support for policy changes mandating later class start times. However, there is plenty of opposition. Schools have cited various reasons for why later school start times would be near impossible to implement such as; 1) Rush-hour traffic worsening from school buses leaving later in the morning and afternoon, creating greater delays and traffic problems for the rest of the community. 2) Younger children not being looked after, if their older siblings are not home from school before them. 3) Extracurriculars may be negatively affected. In some cases, schools have had to shorten practices due to later school start times. Others have rescheduled extracurriculars for the morning hours, effectively negating the benefit of later school start time (Kirby, Maggi, and D'Angiulli, 2011). These are all important hurdles to overcome when implementing later class start times. However, the author's results add to a growing body of literature recommending that changes to school start times are truly needed (Au et al, 2014). Furthermore, this study adds college students' sleep health to the ongoing conversation.

REFERENCES

Åkerstedt, T. (2003). Shift work and disturbed sleep/wakefulness. *Occupational medicine*, *53*(2), 89-94.

Au, R., Carskadon, M., Millman, R., Wolfson, A., Braverman, P. K., Adelman, W. P., & O'Brien, R. F. (2014). School start times for adolescents. *Pediatrics*, *134*(3), 642-649.

Backhaus, J., Junghanns, K., Broocks, A., Riemann, D., & Hohagen, F. (2002). Test–retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. *Journal of psychosomatic research*, *53*(3), 737-740.

Bener, A., Özkan, T., & Lajunen, T. (2008). The driver behaviour questionnaire in Arab gulf countries: Qatar and United Arab Emirates. Accident Analysis & Prevention, 40(4), 1411-1417.

Boergers, J., Gable, C. J., & Owens, J. A. (2014). Later school start time is associated with improved sleep and daytime functioning in adolescents. *Journal of Developmental & Behavioral Pediatrics*, *35*(1), 11-17.

Buysse, D. J., Hall, M. L., Strollo, P. J., Kamarck, T. W., Owens, J., Lee, L., & Matthews, K. A. (2008). Relationships between the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and clinical/polysomnographic measures in a community sample. *Journal of clinical sleep medicine: JCSM: official publication of the American Academy of Sleep Medicine*, *4*(6), 563.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry research*, *28*(2), 193-213.

Calamaro, C. J., Mason, T. B., & Ratcliffe, S. J. (2009). Adolescents living the 24/7 lifestyle: effects of caffeine and technology on sleep duration and daytime functioning. *Pediatrics*, *123*(6), e1005-e1010.

Carskadon, M. A., Dement, W. C., Mitler, M. M., Roth, T., Westbrook, P. R., & Keenan, S. (1986). Guidelines for the multiple sleep latency test (MSLT): a standard measure of sleepiness. *Sleep*, *9*(4), 519-524.

Centers for Disease Control (2016). Teen Driver Fact Sheet. Retrieved from http://www.cdc.gov/motorvehiclesafety/teen_drivers/teendrivers_factsheet.html

Centers for Disease Control. (2016). Parents Are the Key. Retrieved from: http://www.cdc.gov/parentsarethekey/danger/index.html

Charlton, S. G. (2009). Driving while conversing: Cell phones that distract and passengers who react. *Accident Analysis & Prevention*, *41*(1), 160-173.

Curry, A. E., Hafetz, J., Kallan, M. J., Winston, F. K., & Durbin, D. R. (2011). Prevalence of teen driver errors leading to serious motor vehicle crashes. *Accident Analysis & Prevention*, *43*(4), 1285-1290.

Curry, A. E., Pfeiffer, M. R., Durbin, D. R., & Elliott, M. R. (2015). Young driver crash rates by licensing age, driving experience, and license phase. *Accident Analysis & Prevention*, *80*, 243-250.

Dahl, R. E. (2008). Biological, developmental, and neurobehavioral factors relevant to adolescent driving risks. *American journal of preventive medicine, 35*(3), S278-S284.

Danner, F., & Phillips, B. (2008). Adolescent sleep, school start times, and teen motor vehicle crashes. *Journal of clinical sleep medicine: JCSM: official publication of the American Academy of Sleep Medicine*, *4*(6), 533.

Davenne, D., Lericollais, R., Sagaspe, P., Taillard, J., Gauthier, A., Espié, S., & Philip, P. (2012). Reliability of simulator driving tool for evaluation of sleepiness, fatigue and driving performance. *Accident Analysis & Prevention*, *45*, 677-682.

Deffenbacher, J. L., Lynch, R. S., Oetting, E. R., & Yingling, D. A. (2001). Driving anger: Correlates and a test of state-trait theory. *Personality and Individual Differences*, *31*(8), 1321-1331.

De Winter, J. C. F., & Dodou, D. (2010). The Driver Behaviour Questionnaire as a predictor of accidents: A meta-analysis. Journal of safety research, 41(6), 463-470.

Dinges, D. F., Pack, F., Williams, K., Gillen, K. A., Powell, J. W., Ott, G. E., & Pack, A. I. (1997). Cumulative sleepiness, mood disturbance and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep: Journal of Sleep Research & Sleep Medicine*.

Drake, C. L., Roehrs, T., Richardson, G., Walsh, J. K., & Roth, T. (2004). Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers. *Sleep*, *27*(8), 1453-1462.

Giannotti, F., Cortesi, F., Sebastiani, T., & Ottaviano, S. (2002). Circadian preference, sleep and daytime behaviour in adolescence. *Journal of sleep research*, *11*(3), 191-199.

Gonçalves, M., Amici, R., Lucas, R., Åkerstedt, T., Cirignotta, F., Horne, J., & Peigneux, P. (2015). Sleepiness at the wheel across Europe: a survey of 19 countries. *Journal of sleep research*, *24*(3), 242-253.

Groeger, J. A. (2006). Youthfulness, inexperience, and sleep loss: the problems young drivers face and those they pose for us. *Injury prevention*,*12*(suppl. 1), 19-24.

Hagenauer, M. H., Perryman, J. I., Lee, T. M., & Carskadon, M. A. (2009). Adolescent changes in the homeostatic and circadian regulation of sleep. *Developmental neuroscience*, *31*(4), 276-284.

Hayes, A. (2012). PROCESS macro for SPSS and SAS. Retrieved May 10, 2017, from http://www.processmacro.org/index.html

Hershner, S. D., & Chervin, R. D. (2014). Causes and consequences of sleepiness among college students. *Nature and science of sleep*, *6*, 73-84.

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., & Neubauer, D. N. (2015). National Sleep Foundation's sleep time duration recommendations: methodology and results summary. *Sleep Health*, *1*(1), 40-43.

Howard, M. E., Desai, A. V., Grunstein, R. R., Hukins, C., Armstrong, J. G., Joffe, D., & Pierce, R. J. (2004). Sleepiness, sleep-disordered breathing, and accident risk factors in commercial vehicle drivers. *American journal of respiratory and critical care medicine*, *170*(9), 1014-1021.

Insurance Institute for Highway Safety (IIHS) (2012). Fatality facts: teenagers 2012. Arlington (VA) The Institute. Available from: http://www.iihs.org/iihs/topics/t/teenagers/fatalityfacts/teenagers

Jean-Louis, G., Von Gizycki, H., Zizi, F., & Nunes, J. (1998). Mood states and sleepiness in college students: influences of age, sex, habitual sleep, and substance use. *Perceptual and Motor Skills*, *87*(2), 507-512.

Jenni, O. G., Van Reen, E., & Carskadon, M. A. (2005). Regional differences of the sleep electroencephalogram in adolescents. *Journal of sleep research*, *14*(2), 141-147.

Johns, M. W. (1991). A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep*, *14*(6), 540-545.

Johns, M. W. (1992). Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep*, *15*(4), 376-381.

Johns, M. W. (1994). Sleepiness in different situations measured by the Epworth Sleepiness Scale. *Sleep. 17*, 703-703.

Kirby, M., Maggi, S., & D'Angiulli, A. (2011). School start times and the sleep–wake cycle of adolescents: A review and critical evaluation of available evidence. *Educational Researcher*, *40*(2), 56-61.

Knutson, K. L., & Lauderdale, D. S. (2009). Sociodemographic and behavioral predictors of bed time and wake time among US adolescents aged 15 to 17 years. *The Journal of pediatrics*, *154*(3), 426-430.

Lajunen, T., Parker, D., & Summala, H. (2004). The Manchester driver behaviour questionnaire: a cross-cultural study. *Accident Analysis & Prevention*, *36*(2), 231-238.

Lo, J. C., Ong, J. L., Leong, R. L., Gooley, J. J., & Chee, M. W. (2016). Cognitive performance, sleepiness, and mood in partially sleep deprived adolescents: the need for sleep study. *Sleep*, *39*(3), 687-698.

Mardia, K. V. (1974). Applications of some measures of multivariate skewness and kurtosis in testing normality and robustness studies. Sankhyā: *The Indian Journal of Statistics*, Series B, 115-128.

Mesken, J., Hagenzieker, M. P., Rothengatter, T., & de Waard, D. (2007). Frequency, determinants, and consequences of different drivers' emotions: An on-the-road study using self-reports, (observed) behaviour, and physiology. *Transportation research part F: traffic psychology and behaviour*, *10*(6), 458-475.

National Highway Traffic Safety Administration. (2016). Facts and statistics. Retrieved from: http://www.distraction.gov/stats-research-laws/facts-and-statistics.html

National Highway Traffic Safety Administration. (2016). Distraction. Retrieved from: http://www.nhtsa.gov/Research/Crash+Avoidance/Distraction

National Highway Traffic Safety Administration. (2016). Drowsy driving. Retrieved from: http://www.nhtsa.gov/Driving-Safety/Drowsy-Driving

National Sleep Foundation. (2002). 2002 Sleep in america poll executive summary (Rep.). doi:10.1016/j.sleh.2015.04.001

National Sleep Foundation. (2015). National Sleep Foundation Recommends New Times. Retrieved from: https://sleepfoundation.org/media-center/press-release/national-sleep-foundation-recommends-new-sleep-times

Parker, D., McDonald, L., Rabbitt, P., & Sutcliffe, P. (2000). Elderly drivers and their accidents: the Aging Driver Questionnaire. *Accident Analysis & Prevention*, *32*(6), 751-759.

Pilcher, J. J., Ginter, D. R., & Sadowsky, B. (1997). Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *Journal of psychosomatic research*, *42*(6), 583-596.

Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K. (1990). Errors and violations on the roads: a real distinction?. *Ergonomics*, *33*(10-11), 1315-1332.

Reason, J. (1990). *Human error*. Cambridge University press. Cambridge, UK.

Reimer, B., D’Ambrosio, L. A., Gilbert, J., Coughlin, J. F., Biederman, J., Surman, C., & Aleardi, M. (2005). Behavior differences in drivers with attention deficit hyperactivity disorder: The driving behavior questionnaire. *Accident Analysis & Prevention*, *37*(6), 996-1004.

Reynolds 3rd, C. F., Grochocinski, V. J., Monk, T. H., Buysse, D. J., Giles, D. E., Coble, P. A., & Kupfer, D. J. (1992). Concordance between habitual sleep times and laboratory recording schedules. *Sleep*, *15*(6), 571-575.

Riedel, B. W., & Lichstein, K. L. (1998). Objective sleep measures and subjective sleep satisfaction: how do older adults with insomnia define a good night's sleep? *Psychology and Aging*, *13*(1), 159.

Risser, M. R., & Ware, J. C. (1999). Driving Simulation with EEG Monitoring in normals and obstructive sleep apnea patients. In *Annual Proceedings/Association for the Advancement of Automotive Medicine* (Vol. 43, p. 317). Association for the Advancement of Automotive Medicine.

Roenneberg, T., Kuehnle, T., Pramstaller, P. P., Ricken, J., Havel, M., Guth, A., & Merrow, M. (2004). A marker for the end of adolescence. *Current Biology*, *14*(24), R1038-R1039.

Sarwar, S. (2017). Down With 8 A.M. Classes: Undergrads learn better later in the day, study finds. Retrieved May 11, 2017, from http://www.npr.org/sections/ed/2017/04/19/524348257/down-with-8-a-m-classes-undergrads-learn-better-later-in-the-day-study-finds

Smolley, L. A., Ivey, C., Farkas, M., Faucette, E., & Murphy, S. (1993). Epworth sleepiness scale is useful for monitoring daytime sleepiness. *Sleep Res*, *22*, 389.

Strohl KP, Blatt J, Council F, et al. Drowsy driving and automobile crashes: NCSDR/NHTSA expert panel on driver fatigue and sleepiness. Available at: http://www.nhtsa.gov/people/injury/drowsy_driving1/Drowsy.html.

Taylor, D. J., Jenni, O. G., Acebo, C., & Carskadon, M. A. (2005). Sleep tendency during extended wakefulness: insights into adolescent sleep regulation and behavior. *Journal of sleep research*, *14*(3), 239-244.

Vorona, R. D., Szklo-Coxe, M., Lamichhane, R., Ware, J. C., McNallen, A., & Leszczyszyn, D. (2014). Adolescent crash rates and school start times in two central Virginia counties, 2009-2011: a follow-up study to a southeastern Virginia study, 2007-2008. *Journal of clinical sleep medicine: JCSM: official publication of the American Academy of Sleep Medicine*, *10*(11), 1169-1177.

Vorona, R. D., Szklo-Coxe, M., Wu, A., Dubik, M., Zhao, Y., & Ware, J. C. (2011). Dissimilar teen crash rates in two neighboring southeastern Virginia cities with different high school start times. *J Clin Sleep Med*, *7*(2), 145-151.

Watson, N. F., Morgenthaler, T., Chervin, R., Carden, K., Kirsch, D., Kristo, D., & Weaver, T. (2015). Confronting Drowsy Driving: The American Academy of Sleep Medicine Perspective: An American Academy of Sleep Medicine Position Statement. Journal of clinical sleep medicine: JCSM: official publication of the American Academy of Sleep Medicine, 11(11), 1335.

Williamson, A. M., & Feyer, A. M. (2000). Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. *Occupational and environmental medicine*, *57*(10), 649-655.

Wittmann, M., Dinich, J., Merrow, M., & Roenneberg, T. (2006). Social jetlag: misalignment of biological and social time. *Chronobiology international*, *23*(1-2), 497-509.

Zhu, M., Cummings, P., Chu, H., Coben, J. H., & Li, G. (2013). Graduated driver licensing and motor vehicle crashes involving teenage drivers: an exploratory age-stratified meta-analysis. Injury prevention, 19(1), 49-57.

Zuckerman, M. (1996). Item revisions in the sensation seeking scale form V (SSS-V). *Personality and Individual Differences*, *20*(4), 515.

APPENDIX A

EPWORTH SLEEPINESS SCALE

Epworth Sleepiness Scale

Name: ______________________________ Today's date: ____________

Your age (Yrs): __________ Your sex (Male = M, Female = F): ______

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired?

This refers to your usual way of life in recent times.

Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the **most appropriate number** for each situation:

0 = would **never** doze
1 = **slight chance** of dozing
2 = **moderate chance** of dozing
3 = **high chance** of dozing

It is important that you answer each question as best you can.

Situation	**Chance of Dozing (0-3)**
Sitting and reading	___
Watching TV	___
Sitting, inactive in a public place (e.g. a theatre or a meeting)	___
As a passenger in a car for an hour without a break	___
Lying down to rest in the afternoon when circumstances permit	___
Sitting and talking to someone	___
Sitting quietly after a lunch without alcohol	___
In a car, while stopped for a few minutes in the traffic	

THANK YOU FOR YOUR COOPERATION

APPENDIX B

PITTSBURGH SLEEP QUALITY INDEX

The Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions. During the past month,

1. When have you usually gone to bed? ______________
2. How long (in minutes) has it taken you to fall asleep each night? ______________
3. When have you usually gotten up in the morning? ______________
4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed) ______________

5. During the past month, how often have you had trouble sleeping because you…	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times week (3)
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):				
6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)
9. During the past month, how would you rate your sleep quality overall?				

Component 1	#9 Score	C1_______
Component 2	#2 Score (≤15min=0; 16-30 min=1; 31-60 min=2, >60 min=3) + #5a Score (if sum is equal 0=0; 1-2=1; 3-4=2; 5-6=3)	C2_______
Component 3	#4 Score (>7=0; 6-7=1; 5-6=2; <5=3)	C3_______
Component 4	(total # of hours asleep)/(total # of hours in bed) x 100 >85%=0, 75%-84%=1, 65%-74%=2, <65%=3	C4_______
Component 5	Sum of Scores #5b to #5j (0=0; 1-9=1; 10-18=2; 19-27=3)	C5_______
Component 6	#6 Score	C6_______
Component 7	#7 Score + #8 Score (0=0; 1-2=1; 3-4=2; 5-6=3)	C7_______

Add the seven component scores together ________ **Global PSQI Score** ________

APPENDIX C

DRIVING BEHAVIOR QUESTIONNAIRE

1. E Try to pass another car that is signaling a left turn
2. L Select the wrong turn lane when approaching an intersection
3. E Fail to 'Stop' or 'Yield' at a sign, almost hitting a car that has the right of way
4. L Misread signs and miss your exit
5. E Fail to notice pedestrians crossing when turning onto a side street
6. V Drive very close to a car in front of you as a signal that they should go faster or get out of the way
7. L Forget where you parked your car in a parking lot
8. E When preparing to turn from a side road onto a main road, you pay too much attention to the traffic on the main road so that you nearly hit the car in front of you
9. L When you back up, you hit something that you did not observe before but was there
10. V Pass through an intersection even though you know that the traffic light has turned yellow and may go red
11. E When making a turn, you almost hit a cyclist or pedestrian who has come up on your right side
12. V Ignore speed limits late at night or very early in the morning
13. L Forget that your lights are on high beam until another driver flashes his headlights at you
14. E Fail to check your rear-view mirror before pulling out and changing lanes
15. V Have a strong dislike of a particular type of driver, and indicate your dislike by any means that you can
16. V Become impatient with a slow driver in the left lane and pass on the right
17. E Underestimate the speed of an oncoming vehicle when passing
18. L Switch on one thing, for example, the headlights, when you meant to switch on something else, for example, the windshield wipers
19. E Brake too quickly on a slippery road, or turn your steering wheel in the wrong direction while skidding
20. L You intend to drive to destination A, but you 'wake up' to find yourself on the road to destination B, perhaps because B is your more usual destination
21. V Drive even though you realize that your blood alcohol may be over the legal limit
22. V Get involved in spontaneous, or spur-of-the-moment, races with other drivers
23. L Realize that you cannot clearly remember the road you were just driving on
24. V You get angry at the behavior of another driver and you chase that driver so that you can give him/her a piece of your mind

APPENDIX D

SENSATION SEEKING SCALE

Directions: Each of the items below contains two choices A and B. Please indicate which of the choices most describes your likes or the way you feel. In some cases you may find items in which both choices describe your likes or feelings. Please choose the one which better describes your likes or feelings. In some cases you may find items in which you do not like either choice. In these cases mark the choice you dislike least. Do not leave any items blank. It is important you respond to all items with only one choice, A or B. We are interested only in your likes or feelings, not in how others feel about these things or how one is supposed to feel. There are no right or wrong answers as in other kinds of tests. Be frank and give your honest appraisal of yourself.

1. A. I like "wild" uninhibited parties.
B. I prefer quiet parties with good conversation.
2. A. There are some movies I enjoy seeing a second or even third time.
B. I can't stand watching a movie that I've seen before.
3. A. I often wish I could be a mountain climber.
B. I can't understand people who risk their necks climbing mountains.
4. A. I dislike all body odors.
B. I like some of the earthy body smells.
5. A. I get bored seeing the same old faces.
B. I like the comfortable familiarity of everyday friends.
6. A. I like to explore a strange city or section of town by myself, even if it means getting lost.
B. I prefer a guide when I am in a place I don't know well.
7. A. I dislike people who do or say things just to shock or upset others.
B. When you can predict almost everything a person will do and say he or she must be a bore.
8. A. I usually don't enjoy a movie or play where I can predict what will happen in advance.
B. I don't mind watching a movie or play where I can predict what will happen in advance.
9. A. I have tried marijuana or would like to.
B. I would never smoke marijuana.
10. A. I would not like to try any drug which might produce strange and dangerous effects on me.
B. I would like to try some of the drugs that produce hallucinations.
11. A. A sensible person avoids activities that are dangerous.
B. I sometimes like to do things that are a little frightening.
12. A. I dislike "swingers" (people who are uninhibited and free about sex).
B. I enjoy the company of real "swingers."

13. A. I find that stimulants make me uncomfortable.
B. I often like to get high (drinking liquor or smoking marijuana).
14. A. I like to try new foods that I have never tasted before.
B. I order the dishes with which I am familiar so as to avoid disappointment and unpleasantness.
15. A. I enjoy looking at home movies, videos, or travel slides.
B. Looking at someone's home movies, videos, or travel slides bores me tremendously.
16. A. I would like to take up the sport of water skiing.
B. I would not like to take up water skiing.
17. A. I would like to try surfboard riding.
B. I would not like to try surfboard riding.
18. A. I would like to take off on a trip with no preplanned or definite routes, or timetable.
B. When I go on a trip I like to plan my route and timetable fairly carefully.
19. A. I prefer the "down to earth" kinds of people as friends.
B. I would like to make friends in some of the "far-out" groups like artists or "punks."
20. A. I would not like to learn to fly an airplane.
B. I would like to learn to fly an airplane.
21. A. I prefer the surface of the water to the depths.
B. I would like to go scuba diving.
22. A. I would like to meet some persons who are homosexual (men or women).
B. I stay away from anyone I suspect of being "gay" or "lesbian."
23. A. I would like to try parachute jumping.
B. I would never want to try jumping out of a plane, with or without a parachute.
24. A. I prefer friends who are excitingly unpredictable.
B. I prefer friends who are reliable and predictable.
25. A. I am not interested in experience for its own sake.
B. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal.
26. A. The essence of good art is in its clarity, symmetry of form, and harmony of colors.
B. I often find beauty in the "clashing" colors and irregular forms of modem paintings.
27. A. I enjoy spending time in the familiar surroundings of home.
B. I get very restless if I have to stay around home for any length of time.
28. A. I like to dive off the high board.
B. I don't like the feeling I get standing on the high board (or I don't go near it at all).
29. A. I like to date persons who are physically exciting.
B. I like to date persons who share my values.
30. A. Heavy drinking usually ruins a party because some people get loud and boisterous.
B. Keeping the drinks full is the key to a good party.
31. A. The worst social sin is to be rude.

B. The worst social sin is to be a bore.
32. A. A person should have considerable sexual experience before marriage.
B. It's better if two married persons begin their sexual experience with each other.
33. A. Even if I had the money, I would not care to associate with flighty rich persons in the "jet set."
B. I could conceive of myself seeking pleasures around the world with the "jet set."
34. A. I like people who are sharp and witty even if they do sometimes insult others.
B. I dislike people who have their fun at the expense of hurting the feelings of others.
35. A. There is altogether too much portrayal of sex in movies.
B. I enjoy watching many of the "sexy" scenes in movies.
36. A. I feel best after taking a couple of drinks.
B. Something is wrong with people who need liquor to feel good.
37. A. People should dress according to some standard of taste, neatness, and style.
B. People should dress in individual ways even if the effects are sometimes strange.
38. A. Sailing long distances in small sailing crafts is foolhardy.
B. I would like to sail a long distance in a small but seaworthy sailing craft.
39. A. I have no patience with dull or boring persons.
B. I find something interesting in almost every person I talk to.
40. A. Skiing down a high mountain slope is a good way to end up on crutches.
B. I think I would enjoy the sensations of skiing very fast down a high mountain slope.

APPENDIX E

DEMOGRAPHIC QUESTIONS

Demographic Questions:

What is your age in years? (Fill in) ___

What is your gender? (Choices) Male, Female

What is your current academic standing? (Choices) Freshmen, Sophomore, Junior, Senior

Do you have any medical diagnosed sleep problems? (Choices) Yes, No

(**Follow up) Are you being treated for your medical sleep problems?** Yes, No

Do you take daytime naps? (Choices) Yes, No

(Follow up) If so, how many per week? ____

How often do you smoke? (Choices) Everyday, 3-5 times a week, Once or twice a week, I rarely smoke, I do not smoke

How often do you exercise? (Choices) Everyday, 3-5 times a week, Once or twice a week, I rarely exercise, I do not exercise

Do you take care of any children in your home? (Choices) Yes, No

(Follow up) How old is each child? (Fill in) ______ ______ ______ ______

Are you a parent? (Choices) Yes, No, N/A

(Follow up) How old is each child? (Fill in) ______ ______ ______ ______

Do you commute to ODU? (Choices) Yes, No

(Follow up) If so, how long is your average commute in minutes? (Fill in) ___

How many years have you had your driver's license? Please put 0 for less than a year, and N/A if you do not have a driver's license. (Fill in)____

How often do you drive your motor vehicle in a week? (Choices) Everyday, 3-5 times a week, Once or twice a week, I rarely drive, I do not drive/I do not have a car

(Follow up) Estimate miles driven per week. (Fill in) ___

Have you ever received a ticket for a driving violation? (Choices) Yes, No

Have you ever been involved in a traffic accident? (Choices) Yes, No

Have you ever had an accident or near-accident due to sleepiness? (Choices) Never, within the last 6 months, within the last year, within the last 5 years

Fill in/Grid Questions:

When is your earliest class start time for each day of the week?

Monday: (Drop Down Choices for all, 8:00am, 8:30am, 9:00am, 9:30am, 10:00am, 10:30am, 11:00am, 11:30am, 12:00pm, Later than 12:00pm, I don't have class on this day.)

Tuesday:

Wednesday:

Thursday:

Friday:

Do you have obligations before your earliest class? Ex: Work? ROTC? __________

(Follow up) If so, when do you leave in the morning for these obligations?

Monday: (Drop Down Choices for all, Earlier than 6am, 6:00am, 6:30am, 7:00am, 7:30am, 8:00am, 8:30am, 9:00am, 9:30am, 10:00am, 10:30am, 11:00am, After 11am, I don't have this obligation on this day.)

Tuesday:

Wednesday:

Thursday:

Friday:

APPENDIX F

INFORMATION SHEET FOR PSYCHOLOGY PARTICIPANT POOL

Information Sheet
Old Dominion University
College of Sciences
Department of Psychology
Title of Research: Project Sleep Performance
Investigator: Jessica Fry, Ariel Martin and Bryan E. Porter, Ph.D.
Description of Research: This study requires you to fill out several measures concerning sleeping behaviors and driving behaviors. Completion of this study requires approximately 60 minutes.
Exclusionary Criteria: You must be at least 18-years-old and have a valid driver's license.
Risks and Benefits: There are very few risks to completing this questionnaire. As a participant, you may experience an increased self-awareness regarding your driving behavior. However, as a benefit, you may also find the questionnaire interesting and you may learn something about yourself in the process. Also, by taking part in this research, you are creating benefits for the researcher as he continues to learn about the different attitudes and behaviors regarding driver behavior.
Costs and payments: If you decide to participate in this study and are an Old Dominion University student, you will receive 1 Psychology Department research credit that may be applied to course requirements or extra credit in certain Psychology courses. Equivalent credit may be obtained in other ways. You do not have to participate in this study, or any Psychology Department study, in order to obtain this credit. Non-students will not receive compensation for participating.
Anonymity: Your name will not be recorded in connection with the questionnaire you complete. Therefore, your name will not be associated with your responses. Your responses will be completely anonymous. All materials will be coded with a number to keep them together, but this number cannot be traced back to you.
Withdrawal Privilege: You are free to participate in this study or to withdraw at any time. If you wish to withdraw, you may do so without penalty. You may also refuse to answer any question that makes you feel uncomfortable. The investigator also reserves the right to withdraw your participation at any time throughout the investigation.
Contact Information: If you have any further questions concerning this study, please contact:
Primary Investigator: Jessica Fry; 757-683-4452; jxfry001@odu.edu or Dr. Bryan Porter; (757) 683-4458; bporter@odu.edu

Curriculum Vitae

Jessica L. Fry, B.S

Department of Psychology

Old Dominion University

Norfolk, VA 23529

Education

- **Bachelors of Science in Psychology**, Old Dominion University, May 2014. Minor: Human Services, Overall GPA 3.47 (Cum Laude)
- **Masters of Science in Experimental Psychology**, Old Dominion University, Expected Graduation August 2017

  Thesis: *The relationship of early class start times on sleepiness and driving behaviors in an emerging adult population*. (Chair: Dr. Bryan Porter)
- **Masters of Public Health: Behavior Science and Health Education**, Saint Louis University, Expected Graduation May 2018

Research Interests

My focus is on program development, implementation, and evaluation. In particular I am interested in programs relating to health behaviors and injury prevention efforts among emerging adults. I also have a strong interest in technology-based techniques that can be used to easily and quickly disseminate interventions.

Research Experience

- **Research Assistant,** assist Behavioral Psychology Research Analysis Team on seat-belt observation projects, and pedestrian behavior. (Advisor: Dr. Bryan Porter). November 2013 – August 2016.
  - Collected seat-belt observations at various, random sites (roadways) throughout Virginia (1-2 trips a month on weekends).
  - Collected over 20 hours' worth of data on both seat-belt observations and pedestrian behavior at crosswalks around ODU's campus.
  - Surveyed 50 students on campus about their perceived safety and pedestrian/driver behaviors.

Academic Presentations

Fry, J. L., & Porter, B. E. (2017, May). *The relationships of early class start time on sleepiness in an emerging adult population*. Poster session presented at 11th annual Pediatric Science Days, St. Louis, MO.