Student Adjustment to University: Impact of Circadian Misalignment, ADHD Symptomology and Eveningness Chronotype

by

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ABSTRACT

STUDENT ADJUSTMENT TO UNIVERSITY: IMPACT OF CIRCADIAN MISALIGNMENT, ADHD SYMPTOMATOLOGY AND EVENINGNESS CHRONOTYPE

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Adjusting to university can be a challenging time for most young adults. The discrepancy between one’s preferred sleep cycle and the schedule actually followed due to school and work demands (circadian misalignment – hereafter, CM) is an unexplored but potentially important factor that may impact adjustment. This study examined if student adjustment to university could be independently predicted by CM overall, as well as by two subcategories of CM, centering on one’s bed time (evening misalignment – EM) or one’s rise time (morning misalignment – MM). First-year students ($n = 99$) provided measures of their negative emotionality, university adjustment, academic performance, preferred sleep timing, and typical rise & bedtimes at the beginning of the term and two months later. Given the well-documented university adjustment challenges and sleep difficulties experienced by individuals with ADHD symptomology, the associations between ADHD symptoms, misalignment, and adjustment were also examined. A series of hierarchical regression models were used to examine the unique contribution of CM, MM, and EM to student negative emotionality, university adjustment, and academics after controlling for age, gender, ADHD symptomology, sleep timing preferences, and baseline measures of the respective dependent variables. CM made a significant independent contribution to adjustment and academics, but not negative emotionality, while EM significantly contributed to all three dependent measures, and MM did not significantly contribute to any. The results hold
promise for CM – and especially EM – as unique predictors for adjustment in first-year university students. These findings have implications for enabling a more successful transition to university for students with ADHD in particular.
Acknowledgements

“The way is certainly both short and steep,
However gradual it looks from here;
Look if you like, but you will have to leap.”
- W. H. Auden

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Student Adjustment to University: Impact of Circadian Misalignment, ADHD Symptomology and Eveningness Chronotype

The transition to university or other postsecondary education is a significant experience for many adolescents in Western culture, and is even referred to as a “rite of passage” by some (Steinberg, 2014). This transition does not always run smoothly, however, as current estimates predict that almost one third of university students will fail to complete their degree, and the majority of these students will drop out during first year (Bradburn & Carroll, 2002).

Challenges associated with transition to higher education include dramatic increases in the level of independence, available distractions, and responsibility for self-regulation (Farrell, 2003; Meaux, Green, & Broussard, 2009). Taken together, these and other challenges increase the likeliness that students may experience changes in their regular sleep patterns. For example, Afandi et al., (2013) reported that 67.2% of university students sampled reported suffering from poor sleep. Academic performance is significantly impacted by students’ sleep quality, actual sleep timing, and circadian-based sleep timing preferences, underscoring sleep’s importance (Onder et al., 2014).

Due to the aforementioned lifestyle changes, students are more likely to experience an increase in circadian misalignment – the discrepancy between a person’s actual sleep timing, and the sleep timing they would prefer based on circadian preferences (often referred to as “chronotype”). Chronotypes are enduring, individual patterns of sleep-wake preferences. These preferences are often subdivided into “night owl or evening-preference” referring to individuals with a late night, late rise preferred cycle, and “early lark or morning-preference” representing those who prefer an early-to-bed and early-to-rise sleep pattern. In the case of a student
transitioning to university, these preferences may be disrupted. For example, students may prefer to work until 2:00 am and sleep until 10:00 am, but they are enrolled in 8:30 am classes requiring them to adjust their sleep cycles. This shift results in increased circadian misalignment. Additionally, students with ADHD are known to be particularly vulnerable to experiencing misalignment with later circadian preference (i.e. an “evening-preference”, Caci, Bouchez, & Bayle, 2009). The impact of increases in circadian misalignment on the already-heightened risk for negative outcomes experienced by students with ADHD symptoms is currently unknown.

This study explored the unique and combined effects of circadian misalignment on students’ adjustment to university during their first term of study. The relations between ADHD symptomology and evening-preference on student adjustment to university were also examined after removing the predictive effects of circadian misalignment and sleep loss. To lay the foundation for the study, relevant concepts and literature from the following areas are summarized: the morningness-eveningness chronotype, circadian misalignment, relations between ADHD and both sleep dysregulation and chronotype, and the potential impact of ADHD symptoms in first-year university students.

**Morningness-Eveningness Chronotype**

An individual’s chronotype describes a biological preference for a certain sleep schedule (Roenneberg et al., 2007). Morning-types, or “early larks” – those who score higher on “morningness” – prefer an early-to-bed, early-to-rise sleep schedule, feel best in the morning, and grow progressively less alert throughout the day. Evening-types, or “night owls”, score higher on “eveningness” and prefer a late to bed, late to rise schedule, feel best in the evening, and become progressively more alert throughout the day (Baron & Reid, 2014).
Chronotype arises from intrinsic biological processes, and therefore, is not thought to be amenable to change via lifestyle choice (Carskadon, 2011). For instance, a person could adhere to an early-to-bed, early-to-rise sleep schedule due to situational factors such as job or school requirements, but still have an innate evening-preference. Chronotype is dictated by the timing of the biochemical rhythms of the body, which are set by the circadian pacemaker of the brain (the suprachiasmatic nucleus or SCN; Roenneberg et al., 2007; Sylvester et al., 2002), which is responsible for regulating the daily timing of sleep-wake cycles, fluctuations in core body temperature, and release of chemicals from the endocrine system such as melatonin, cortisol, and growth hormone (Baron & Reid, 2014; Horne & Ostberg, 1975; Randler & Schaal, 2010; Roenneberg et al., 2007). Chronotype is also at least partially determined by genetics (Katzenberg et al., 1998; Mishima et al., 2005; Roenneberg et al., 2007; Vink, Groot, Kerkhof, & Boomsma, 2001).

Generally, chronotype forms a normal distribution in the population, with most people clustered in the middle, and progressively fewer people at the tail-ends of either "extreme morning-type" or "extreme evening-type" (Roenneberg et al., 2007). Individuals tend to retain their relative positions in comparison to others of the same age and sex throughout the lifespan. However, chronotype undergoes clear patterns of change within an individual’s life, as there are large, systematic differences when comparing age groups and the sexes (Drennan, Klauber, Kripke, & Goyette, 1991). Over time, individual changes in chronotype follow a systematically different pattern for men and women in a way that coincides with the hormonal changes of sexual development (Andrade et al., 1993; Carskadon, Vieira, & Acebo, 1993; Roenneberg et al., 2004). Although peak "eveningness" occurs, on average, at age 20, this differs based on sex. Girls tend to reach this peak at around 19.5 years, while boys reach peak eveningness later,
around age 21, coinciding with their general tendency to reach sexual maturity later than girls (Roenneberg et al., 2004). Thus, the transition to university, which occurs at age 18 for 73% of Canadians, represents a time near peak “eveningness” for the majority of students (Canadian University Survey Consortium, 2007).

In addition to biological differences, a large body of research has found differences between individuals with morning and evening preference in a number of domains. Evening-types have been shown to differ from morning-types in personality and thinking styles (Cavallera & Giampitero, 2007; Giampietro & Cavallera, 2007). Evening-types are also at increased risk for a variety of negative outcomes, including poorer academic achievement and physical health problems (e.g., Taylor, Clay, Bramoweth, Sethi, & Roane, 2011; Vollmer, Potsch, & Randler 2013). Mental health differences have also been demonstrated, as higher symptoms of depression and anxiety, among others, have been reported by evening-types (e.g., Chelminski, Ferraro, Petros, & Plaud, 1999; Randler, 2011. Evening-types also report engaging in more risk-taking behaviours, such as smoking cigarettes and drinking alcohol, and report higher levels of sensation seeking (e.g., Adan, 1994; Tavernier & Willoughby, 2013; Wittman, Paulus, & Roenneberg, 2010).

Compared to morning-types, evening-types also tend to experience more sleep problems (e.g., Taylor et al., 2011; Voinescu, Szentagotai, & David, 2012), and less hours of sleep overall (e.g. Kabrita et al., 2014; Kitamaru et al., 2010). Evening types also report experiencing more circadian misalignment than morning-types do (e.g., Levandovski et al., 2011; Simor et al., 2015). Thus, many researchers have wondered if the many negative outcomes experienced by evening-types can be solely attributed to the reductions in sleep quality and quantity they experience. However, recent work has shown that having an evening preference is an
independent risk factor for symptoms of depression, anxiety, and negative emotionality in the general population, even after controlling for participants’ levels of circadian misalignment and quality and quantity of sleep (e.g., Kitamuru, 2010; Simor, 2015). These findings have been replicated in clinical populations, as patients with a diagnosis of depression display a greater tendency to be evening-types, even after controlling for sleep-related factors such as insomnia, sleep quality, and sleep duration (e.g., Anytpa et al., 2015; Muller, Kundermann, & Cabanel, 2015). Thus, research to date suggests that a person’s chronotype can predict health outcomes independent of both sleep dysregulation and circadian misalignment experienced. Morning-types and evening-types represent unique groups of individuals who display different personality traits and experience differential risk for numerous negative outcomes. Of critical importance to the current research is the fact that evening-preference is correlated with increased endorsement of ADHD symptoms, and that individuals with a diagnosis of ADHD are significantly more likely to report a later sleep-timing preference (e.g., Caci, Bouchez, & Bayle, 2009; Lange & Randler, 2011).

**Circadian Misalignment**

Circadian misalignment represents the mismatch between a person’s preferred sleep schedule (i.e. chronotype) and the actual sleep schedule they adhere to in daily life, usually due to demands associated with social activities, school, or work (Baron & Reid, 2014). As might be expected, greater circadian misalignment is strongly associated with sleep variables such as, reductions in sleep quality and quantity, and increases in daytime fatigue (e.g., Levandovski et al., 2011; Simor et al., 2015). Increased circadian misalignment is also related to negative physical and mental health outcomes, including depression and breast cancer (e.g., Emens et al., 2009; Hahm et al., 2014). Increases in health-impairing behaviours, such as smoking cigarettes
and drinking alcohol, are also related to increased misalignment, as are decreases in attention, mental balance, and mental and physical vigor (Wittman, Paulus, & Roenneberg, 2010).

The pervasive and detrimental effects of sleep loss on physical and mental health are well documented (Colten & Altevogt, 2006). Therefore, it is easy to assume that the negative outcomes faced by those with increased misalignment could be explained solely by the sleep problems they often experience. However, research has begun to examine the possibility that sleep disturbances and circadian misalignment may be separate constructs with unique predictive utility. For example, in a study of insulin sensitivity in night shift workers, Leproult, Holmbäck, & Van Cauter (2014) found evidence that circadian misalignment is a risk factor for diabetes, even when controlling for sleep loss. Additionally, sleep deprivation and chronic circadian misalignment have opposing effects on cortisol levels, with the former increasing cortisol levels, and the latter reducing them, further supporting the idea that they are distinct constructs (Wright et al., 2015).

Understanding the unique impact that circadian misalignment has on physical and mental health is further complicated by the fact that it is much more likely for people to experience misalignment if they show a preference for a later sleep timing schedule (i.e. an evening-preference chronotype). As noted above, chronotype itself can predict health outcomes independent of both sleep dysregulation and circadian misalignment experienced. In parallel, circadian misalignment demonstrates its own unique predictive ability for mental and physical health outcomes, even after controlling for chronotype and sleep variables. For example, significant, positive correlations have been found between degree of misalignment and both symptoms of depression in normative adult populations (Levandovski et al., 2011), and breast cancer incidence in night shift workers (Davis, Mirick, & Stevens, 2001). Furthermore, in a
longitudinal study of breast cancer survivors, circadian misalignment was associated with shorter cancer-free intervals and more rapid disease progression, even after controlling for the effects of chronotype (Hahm et al., 2014). Although current research on the independent roles of chronotype and circadian misalignment on physical health is sparse, emerging evidence supports the notion of both being separate constructs with unique predictive utility. Taken together, this research highlights the importance of examining both chronotype and misalignment as well as sleep amount. Of particular interest in the current study is the separate and combined effects of these variables for individuals with ADHD who are adjusting to university. In the following section, key literature on the impact of ADHD on university adjustment and associations between ADHD and the sleep variables under study are briefly reviewed.

**Students with ADHD**

Of all post-secondary students, it is estimated that between 0.5% and five percent have a diagnosis of ADHD, with two to eight percent displaying symptoms of ADHD severe enough to warrant diagnosis (DuPaul, Weyandt, O’Dell, & Varejao, 2009; Farrell, 2003). According to DuPaul, Weyandt, O’Dell, & Varejao (2009), 25% of all university students registered with disability services have ADHD. Further, ADHD is associated with poor academic performance, higher school drop-out rates, and lower life-long educational attainment (Loe & Feldman, 2006). ADHD is often comorbid with other disorders, including anxiety, depression, learning disabilities, and substance abuse disorders (American Psychiatric Association, 2013). Taken together, ADHD poses a threat to the health and academic and occupational success of a significant portion of society.

Individuals with ADHD experience increased risk for a number of negative academic and mental health outcomes. Considering that first year students are generally more likely to
experience academic drop-out and depression, students with ADHD are at heightened risk for experiencing difficulties during this transition (Bradburn & Carroll, 2002; Rawana & Morgan, 2014). These difficulties include academic failure, decreased quality of life, development of psychopathologies, and increased engagement in health-risk behaviours such as smoking, drinking alcohol, and using illicit drugs (Farrell, 2003; Grenwald-Mayes, 2002; Maitland, 2015; Rabiner et al., 2008). While it is clear that university students with ADHD are more vulnerable to negative personal, health, and academic outcomes, the mechanisms underlying this heightened risk remain unclear. Farrell (2003) points to the variability in daily class start and end times as an obstacle to success for students with ADHD, particularly in regards to regulating their often problematic sleep schedules.

**ADHD & Sleep**

Research has consistently demonstrated that both children and adults with ADHD are more likely to show symptoms of dysregulated sleep, including sleep difficulties, daytime fatigue, poorer sleep quality, and sleep-onset insomnia (e.g., Corkum, Tannock, & Moldofsky, 1998; Van Veen et al., 2010). The use of stimulant medications is not hypothesized to account for these difficulties, as studies have shown no group differences in medicated and non-medicated ADHD patients on both subjective and objective measures of sleep quality (O’Brien et al., 2003).

Although difficulty waking up in the morning is commonly reported among university students in general, students with ADHD are impaired by their inability to wake up on time for classes to a much greater degree, and may engage in a variety of techniques to solve this problem (e.g., complicated alarm setting routines; Meaux, Green, & Broussard, 2009). In a qualitative study of post-secondary students diagnosed with ADHD by Meaux, Green, & Broussard (2009), participants continually described difficulty sleeping – specifically, waking in the morning or
going to bed early enough – as a major barrier to their academic success and daily self-management. Many described failing courses solely due to absences caused by sleeping in. Other students stressed the importance of scheduling classes later in the day because of their known inability to wake up early enough. Taken together, this study underscores that “sleeping in” can be a source of continued difficulty in the lives of many students with ADHD.

Even when full diagnostic criteria are not met, self-reported ADHD symptomology is related to both current and lifetime sleep problems in college students and adults (Gau et al., 2007; Voinescu, Szentagotai, & David, 2012). Given that an increase in sleep problems often occurs during the transition to university for students in general, and that students with ADHD are more likely to enter university with a propensity for experiencing problematic sleep, it is possible that sleep problems in individuals with ADHD are a major risk factor for problems encountered during transition (Meaux, Green, & Broussard, 2009). However, the dysregulated sleep experienced by students with ADHD may be better understood within the context of the relationship between ADHD and the morningness-eveningness chronotype.

**ADHD & Chronotype**

The relationship between ADHD symptomology and sleep problems is more complicated than it appears on the surface. Not only are individuals with ADHD more likely to experience dysregulated sleep, but they are also disproportionately more likely to display a preference for a late-to-bed, late-to-rise sleep cycle, otherwise known as an “evening-preference” (Caci, Bouchez, & Bayle, 2009; Lange & Randler, 2011; Voinescu, Szentagotai, & David, 2012).

As previously noted, significant correlations between evening-preference and increases in ADHD symptomology have been found, although there is a paucity of research on the exact nature of this relationship. When comparing individuals with and without a diagnosis of ADHD,
the association is clearer; those with a diagnosis endorse a preference for a significantly later chronotype, and are found to wake up at a significantly later time of day when compared to controls (Bijlenga et al., 2011; van der Heijen et al., 2005b). However, when examined by symptom subtype, two separate studies found significant correlations between evening-preference and the endorsement of inattentive ADHD symptoms, but no relationship with hyperactive-impulsive symptoms (Caci, Bouchez, & Bayle, 2009; Voinescu, Szentagotai, & David, 2012). In contrast, a study conducted by Lange & Randler (2011) did find a significant relationship between evening-preference and the hyperactive/inattentive subscale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Further complicating the picture, Bae et al. (2010) found gender differences in the relationship between ADHD subtypes and chronotype, as the endorsement of both inattentive and hyperactive-impulsive symptoms correlated with evening-preference in male subjects, whereas in female subjects, only the endorsement of inattentive symptoms was related to chronotype. Taken together, clear correlations exist between evening-preference and both subtypes of ADHD symptomology, although the exact nature of these relationships requires further investigation. To date, the research literature has yet to concurrently examine both sleep dysregulation and chronotype in the context of ADHD symptomology, which may partially explain the mixed results.

Previously, evidence for chronotype being partially controlled by the endocrine system was overviewed. Interestingly, individuals with ADHD have displayed similar alterations in the timing of endocrine system activity as evening-types do. When compared to controls, individuals with ADHD have shown differences in the timing of their cortisol and melatonin release, as well as differences in their core body temperature (Baird et al., 2012; Bijlenga et al., 2013; Kaneko et al., 1993). Further, sleep disturbances are common in individuals with ADHD, and they display
more instability and less predictability in their patterns of activity and rest during the day and at night (Gruber & Sadeh, 2000). Therefore, individuals with ADHD and evening-types are at risk for the same circadian disruptions, and similar patterns of neurological functioning and genetic variation have been found in both groups (e.g. Katzenberg et al., 1998; Mishima et al., 2005; Sylvester, Krout, & Loewry, 2002; Xu et al., 2010).

Additionally, individuals with ADHD display heightened risk for the same negative outcomes that evening-types are especially vulnerable to, such as poorer academic performance, sleep problems, internalizing problems, substance abuse, sensation seeking, and engagement in health-risk behaviours (e.g., Hsu et al., 2012; Simor et al., 2015). In sum, many lines of research have demonstrated a link between ADHD symptomology and chronotype. Consequently, individuals with ADHD can be conceptualized as particularly vulnerable undergraduate population as function of both their ADHD diagnosis and their association with evening-preference.

**Considering ADHD and Chronotype When Studying Misalignment**

First-year students can be more vulnerable to negative outcomes (e.g. depression, poor academic achievement, dropping out) due to a number of factors. First-year students often report sleep problems, and they experience a lifestyle transition and increases in responsibility for self-regulation concurrently (Afandi et al., 2013; Farrell, 2003). As the typical average age of first-year students is 18 years, they are also more likely to have an evening-preference at this time than during other points of their lives, and are more susceptible to depression (Rawana & Morgan, 2014; Roenneberg et al., 2007)

A significant proportion of first-year students report a diagnosis or symptoms of ADHD, which increases their vulnerability to these negative outcomes (DuPaul, Weyandt, O’Dell, &
Varejao, 2009; Grenwald-Mayes, 2002; Rabiner et al., 2008). Further, those with ADHD are significantly more likely to have an evening-preference, and evening-types are at heightened risk for many negative outcomes (Bijlenga et al., 2011; Hsu et al., 2012). Thus, first-year university students with symptoms of ADHD and an evening-preference constitute a particularly vulnerable group who are more likely to experience negative outcomes and dysregulated sleep (Corkum et al., 1999; Levandovski et al., 2011). Both evening-preference and dysregulated sleep also have well-established relationships to increases in circadian misalignment (Bae et al., 2010; Baron & Reid, 2014); however, ADHD and circadian misalignment have not yet been studied together.

Circadian misalignment has already demonstrated predictive utility for some physical health issues, but the current study is the first to examine if circadian misalignment is an independent risk factor for mental health issues when both chronotype and sleep loss are controlled for, specifically in the context of adjustment to university. Additionally, this is the first known study to examine the relationship between ADHD symptoms and circadian misalignment while controlling for sleep loss.

Objectives and Hypotheses

The current study used a longitudinal design to explore the impact of circadian misalignment on first-year student's adjustment to university, including their academic performance, emotionality, attachment to their institution, and psychosocial functioning. The impact of a student's pre-existing level of ADHD symptomology and chronotype on the relationship between misalignment and university adjustment were also examined. Specifically, the study posed the following questions:

1. Does circadian misalignment make a significant contribution to negative emotionality (i.e. symptoms of depression, anxiety, and stress), independent of the effects of sleep
loss, evening-preference, and self-reported ADHD symptomology? It is hypothesized that the degree of misalignment alone will predict negative emotionality, even after controlling for ADHD symptomology, chronotype, and amount of sleep the student receives.

2. Does circadian misalignment make a significant contribution to adjustment to university, independent of the effects of sleep loss, evening-preference, and self-reported ADHD symptomology? It is hypothesized that the degree of misalignment alone will predict adjustment to university, even after controlling for ADHD symptomology, chronotype, and amount of sleep the student receives.

3. Does circadian misalignment make a significant contribution to academic performance in university, independent of the effects of sleep loss, evening-preference, and self-reported ADHD symptomology? It is hypothesized that the degree of misalignment alone will predict student academic performance, even after controlling for ADHD symptomology, chronotype, and amount of sleep the student receives.

4. Is ADHD symptomology an independent risk factor for poor university adjustment, even after controlling for circadian misalignment and sleep loss? It is hypothesized that after controlling for circadian misalignment and hours of sleep, ADHD symptomology will no longer significantly predict negative emotionality, adjustment to university, or academic performance in first-year university students.

5. Is evening-preference an independent risk factor for poor university adjustment, even after controlling for circadian misalignment and sleep loss? It is hypothesized that after controlling for circadian misalignment and hours of sleep, eveningness will no longer
significantly predict negative emotionality, adjustment to university, or academic performance in first-year university students.

Methodology

Participants

First-year undergraduate students enrolled in an introductory psychology course during the Fall 2016 term at University of Guelph, Ontario were recruited for this study. Students were recruited through University of Guelph's SONA Psychology Participant Pool and were given both course credit (1% of their final grade) and an opportunity to be entered into a draw for a gift card in exchange for their participation in the study. All study participants were in their first term of university education, were between the ages of 17-21, and lived in on-campus student housing (e.g. "residence"). These criteria were chosen given the focus on the typical first year experience for students. More mature students or students living at home were not included in the study as their adjustment experiences may vary from those of first year students living in residence. 158 students (15 males and 143 females) agreed to participate in the study.

Measures

The Adult ADHD Self-Report Scale

The Adult ADHD Self-Report Scale (ASRS, see Appendix A), a self-report measure of ADHD symptom frequency over the previous six months, is often used as a screener for ADHD symptoms in the general population (Kessler et al., 2005). The ASRS contains 18 items each rated on a 5-point scale from 0 (never) to 4 (very often). Item responses are combined into two subscales: Inattention (measuring frequency of inattentive symptom clusters), and Hyperactivity-Impulsivity (measuring frequency of hyperactive and impulsive symptom clusters). Overall, the ASRS has demonstrated high internal consistency of 0.88 (Rosler & Stieglitz, 2010), and in
adolescent populations, it has demonstrated internal consistency of 0.87 and 0.89 for the Inattention and Hyperactivity-Impulsivity subscales respectively (Sonnby et al., 2015). The ASRS has also evidenced high concurrent validity with a clinician-administered ADHD Rating Scale (Adler et al., 2006), as well as good test-retest reliability in a sample of adults seeking treatment for ADHD, with an intraclass coefficient of 0.86 (Matza et al., 2010). In the current study, the ASRS demonstrated good internal consistency, with a Cronbach’s alpha value of .85.

*Morningness-Eveningness Questionnaire*

The Morningness-Eveningness Questionnaire (MEQ, see Appendix B) is a 19-item self-report measure used to assess a person’s preferred sleep timing (Horne & Ostberg, 1975). The MEQ categorizes people into three groups (morning, evening, or intermediate) according to the time of day they reach peak alertness based on their circadian rhythm or biological clock. Most questions are rated on a 4-point Likert scale, while a few of the questions are responded to by recording preferred hours of sleep and wakefulness on a scale. The MEQ is considered the gold standard measure of morningness-eveningness in the literature, and has been cited over 3000 times (Di Milia et al., 2013). The MEQ is psychometrically sound as indicated by good internal consistency (e.g, Cronbach's alpha of 0.83 reported by Horne & Ostberg, 1975). An individual’s score on the MEQ consistently correlates with markers of peak biological alertness, demonstrating concurrent validity (Horne & Ostberg, 1975). In the current study, the MEQ demonstrated good internal consistency, with a Cronbach’s alpha value of .78.

*Circadian Misalignment*

Circadian misalignment measures the degree of mismatch between a person’s natural sleep timing preferences based on their circadian rhythm (as measured by the MEQ) and their usual sleep habits. Participants were asked to report their typical bed times and rise times on a
This scale was developed based on a review of typical methods of measuring circadian misalignment in this area of research, and based on an approach that has been successfully utilized in other published studies (see Simor et al., 2015).

For each participant, circadian misalignment variables were calculated separately for Time1 and Time2. Variables were calculated in the following manner:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Method of calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning Misalignment (MM)</td>
<td>The absolute value of: preferred rise time (Q1 of the MEQ) minus average rise time ([actual rise time on weekdays (Q1 of the Circadian Misalignment scale) times five] plus [actual rise time on weekends (Q4 of the Circadian Misalignment scale) times two])</td>
</tr>
<tr>
<td>Evening Misalignment (EM)</td>
<td>The absolute value of: preferred bed time (Q2 of the MEQ) minus average bed time ([actual bed time on weekdays (Q2 of the Circadian Misalignment scale) times five] + [actual bed time on weekends (Q5 of the Circadian Misalignment scale) times two])</td>
</tr>
<tr>
<td>Total Circadian Misalignment (CM)</td>
<td>MM plus CM</td>
</tr>
</tbody>
</table>

**Hours Slept**

For each participant, hours slept was calculated separately for two time points representing the beginning (Time1) and end (Time2) of the fall semester of the first year in
university. Variables were calculated using the questions in the Circadian Misalignment scale in the following manner:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Method of calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours Slept per Weekday</td>
<td>Actual rise time on weekdays (Q1 of the Circadian Misalignment scale) minus actual bed time on weekdays (Q2 of the Circadian Misalignment scale)</td>
</tr>
<tr>
<td>Hours Slept per Weekend</td>
<td>Actual rise time on weekends (Q4 of the Circadian Misalignment scale) minus actual bed time on weekends (Q5 of the Circadian Misalignment scale)</td>
</tr>
<tr>
<td>Total Hours Slept per Week</td>
<td>(Hours Slept per Weekday times 5) plus (Hours Slept per Weekend times two)</td>
</tr>
</tbody>
</table>

*The Depression Anxiety Stress Scales*

The Depression Anxiety Stress Scales (DASS, see Appendix D) is a 42-item self-report measure consisting of three subscales, which measure depression, anxiety, and stress (Lovibond & Lovibond, 1995a). The DASS provides an overall measure of negative emotional states experienced over the past week. The three subscales are each divided into further subscales. The Depression subscales are: dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia, and inertia. The Anxiety subscales include: autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The Stress subscales are: difficulty relaxing, nervous arousal, and being easily upset/agitated, irritable/over-reactive, and impatient. Each item is scored on a 4-point Likert scale ranging from 0 (*did not apply to me at all*) to 3 (*applied to me very much/most of the time*). The DASS has
demonstrated excellent internal consistency, with Cronbach’s alpha estimates of .97, .92, and .95 for the depression, anxiety, and stress subscales, respectively (Antony et al., 1998). The DASS correlates with other existing depression and anxiety measures such as the Beck Depression Inventory (BDI) and the Beck Anxiety Inventory (BAI; Lovibond & Lovibond 1995b). In the current study, the DASS demonstrated excellent internal consistency, with a Cronbach’s alpha value of .97 at Time1, and .98 at Time2.

The Student Adaptation to College Questionnaire (SACQ, see Appendix E) is a self-report measure of a student’s adjustment to post-secondary education, and is often used to detect problems with a student’s transition and identify those at risk for dropping out (Baker & Siryk, 1989). The SACQ is a 67-item measure rated on a 9-point Likert scale from 1 (applies very closely to me) to 9 (doesn’t apply to me at all), and breaks down into four main subscales, each of which can be further divided into clusters. The Academic Adjustment scale measures how well a student is coping with educational demands, and breaks down into four clusters: motivation, application, performance, and academic environment. The Social Adjustment scale measures how well a student copes with interpersonal-societal demands, also breaking down into four clusters: general, other people, nostalgia, and social environment. The Personal-Emotional Adjustment scale measures how a student is feeling overall, and provides two cluster scores: psychological and physical adjustment. The Attachment scale measures how attached the student feels to the institution, including their satisfaction with college experience in general (general cluster) and their satisfaction with the school they chose to attend in particular (this college cluster). A Full Scale composite measure of overall adjustment can also be derived (Baker & Siryk, 1989). The SACQ is psychometrically sound, with Cronbach alpha coefficients ranging
between .92 and .95 for the Full Scale score, and alphas between .81 to .90 for Academic Adjustment, .83 to .91 for Social Adjustment, .77 to .86 for Personal-Emotional Adjustment, and .85 to .91 for Attachment (Taylor & Pastor, 2007). Evidence for the validity of this measure has also been established, with significant correlations found between the SACQ and student GPA, academic performance, student contact with university counseling services, and attrition (Taylor & Pastor, 2007). In the current study, the SACQ demonstrated excellent internal consistency, with a Cronbach’s alpha value of .95 at Time1, and .94 at Time2.

**Academic Performance**

Participants were asked two questions related to their previous and current academic performance. The questions were answered on a 6-point scale ranging from 1 (*below 50%*) to 6 (*between 90-100%*). In Time1 of the study, students were asked about their academic performance during their last two years of high school, and during Time2, they were asked about their performance during the current University term (see Appendix F).

**Additional Questions**

In addition to the above measures, participants were asked questions for control purposes about their diagnostic history and current medication use (see Appendix G).

**Procedure**

Ethics approval was granted from the University of Guelph Research Ethics Board (REB #16AU036, see Appendix H). The study was comprised of two phases of data collection. Time1 was conducted in September 2016. At that time, 158 participants were recruited through University of Guelph's SONA Psychology Participant Pool and were offered .5 credit towards their course grade in exchange for participation. After signing up through the SONA system, participants were emailed a link to complete the study online in Qualtrics, where they answered
the entire battery of measures. Completion of all study questionnaires took approximately 30 minutes.

Time2 was conducted between late-November and early-December 2016. All 158 participants who provided data at Time1 were emailed a link to provide data for Time2 online in Qualtrics (see Appendix I for script). In all, 92 participants chose to complete Time2 of the study, and were offered a .5 credit towards their course and an opportunity to enter into a draw for a University of Guelph gift card in exchange for participation. During Time 2, participants completed a subset of the previously described measures including the DASS, Circadian Misalignment, SACQ, and Academic Performance measures. They were also asked to report on their typical hours slept during the term. Time2 took approximately 20 minutes to complete. During both parts of the study, participants were informed that their data would remain confidential, and they were able to withdraw from the study at any time (see Appendix J). After completing Time2 measures, participants were provided with a debriefing form in which they were informed of the theory behind and purpose of the study, guided to university resources should they have experienced any psychological distress, and given the names and contact information of the experimenters, in case they wished to ask further questions (see Appendix K).

Results

Data Screening

Prior to analysis, the data were screened for: out of range values and outliers, incorrectly recorded or incoherent responses, and missing data. As adapted from Acock (2005), when 80% or more of the data was completed in a given subscale, a missing value was replaced by the mean value for that subscale. If less than 80% of the questions in a particular subscale were completed, the entire subscale was recorded as missing and no data were entered for that scale or subscale.
After applying this method, 85 participants had full data included for analyses for the DASS, 75 for the SACQ, and 88 for the Academic Performance measure. In keeping with Cohen’s (1992) recommendations for detecting effect sizes at an alpha of .05 with six predictor variables, 45 participants are required for 80% power; therefore, the study was appropriately powered to detect large effect sizes, but underpowered to detect small or medium effect sizes. All full scale measures (e.g. the ASRS, MEQ, DASS, and SACQ) demonstrated good to excellent internal consistency, with Cronbach’s alpha values ranging from .78 to .98 (George & Mallery, 2003).

**Descriptive Statistics**

All participants were between 17 and 20 years old ($M = 220.50$ months, $SD = 5.95$). The gender distribution was uneven, with $n = 9$ males, $n = 79$ females, and one self-identified as “other”, retained for final analyses. Overall, only two participants reported having a diagnosis of ADHD, and no participants reported having a diagnosed Learning Disability. After conducting independent samples t-tests for all variables based on participant gender, significant mean differences emerged. Specifically, at Time1, males reported significantly less negative emotionality, higher academic performance, and more hours sleep than females did. As a result, gender was controlled for in subsequent analyses (see Table 1 for means and standard deviations of all study variables by participant gender).

Relationships between all independent variables were first assessed using Pearson correlations (see Table 2). All Time1 variables were significantly and positively correlated with the same measure at Time2. At Time1, older students tended to experience more negative emotionality (i.e. the DASS; $r(90) = .22, p < .05$) and poorer student adjustment (i.e. the SACQ, $r(90) = -.24, p < .05$), although these relationships were not present with Time2 measures of the same variables. As a result, age was controlled for in subsequent analyses.
As expected based on existing literature, ADHD symptomology (i.e. the ASRS) had strong, positive relationships to negative emotionality (i.e. the DASS) at both time points ($r(90) = .50, p < .001$ at Time1, $r(90) = .35, p < .01$ at Time2), as well as strong, negative relationships with university adjustment (i.e. the SACQ) at both time points ($r(90) = -.43, p < .01$ at Time1, $r(90) = -.37, p < .01$ at Time2). Also as expected based on previous research, a strong, negative correlation existed between the ASRS and the MEQ ($r(90) = -.47, p < .01$), meaning that as ADHD symptomology increased, student endorsement of evening-preference tended to increase, and as ADHD symptomology decreased, student endorsement of morning-preference tended to increase. The MEQ also negatively correlated with the SACQ ($r(90) = -.28, p < .05$ at Time1, $r(90) = -.31, p < .01$ at Time2), meaning that as evening-preference increased, student adjustment tended to decrease. The DASS and the SACQ had strong, negative relationships to one another, ($r(90) = -.45$ to $-.74, p < .01$ across Time1 and Time2), indicating that as negative emotionality increased, student adjustment tended to decrease.

Hours of sleep per week at either time point had no relation to any other variables in the study, and neither did morning misalignment. Evening misalignment was related only to student adjustment at Time2 ($r(90) = -.30, p < .01$), and total misalignment was related only to academic performance at Time2 ($r(90) = -.23, p < .05$).

**Regression Analyses**

The hypotheses were tested using a series of hierarchical linear regression models using SPSS software, version 21. The data were examined visually to ensure assumptions for linear regression models were met. For all regression models, the values of the residuals were checked visually using histograms and Q-Q plots and appeared to follow a normal distribution. Additionally, values of kurtosis and skew for both standardized and unstandardized residuals
were examined, and all values fell within acceptable limits for normality (i.e. between +2 and -2, George & Mallery, 2003). Visual examination of scatterplots comparing residuals to predicted values showed good evidence of both a linear relationship between variables and homoscedasticity within the data, as no evidence of a relationship between error terms was apparent. Variance inflation factors (VIFs) were under a value of 2 for all regression models, thus providing good evidence that the data did not display multicollinearity (VIFs should be under 10 to demonstrate that residuals are unrelated, Myers, 1990). Multivariate outliers were screened for using Cook’s D, and none were detected (i.e. no values of Cook’s D were greater than 1 for any regression model, Field, 2013).

**Hypothesis One**

Hypothesis one predicted that the degree of misalignment would predict self-reported negative emotionality (i.e., DASS score), even after controlling for ADHD symptomology, chronotype, and amount of sleep received. To test this hypothesis, a series of hierarchical linear regression analyses were conducted to predict DASS score at Time2. Step 1 always included: gender, age in months, the ASRS, the MEQ, hours of sleep per week at both Time1 and Time2. Time1 DASS score was also included in Step 1. This model was significant, accounting for 46.8% of the variance in Time2 DASS scores, \( F(7,77) = 9.69, p < .001, R^2 = .47 \).

A series of 3 separate regression analyses were then performed in which Step 2 examined the change in either morning misalignment (MM), evening misalignment (EM), or total misalignment (CM) over the course of the term. Change in morning misalignment over the course of the term was found to uniquely predict only 1.1% (ns) of the variance in Time2 DASS scores after controlling for all other variables, and thus, this model did not significantly increase the variance accounted for from Step 1, \( F(8,76) = 8.73, p < .001, R^2 = .48 \). Change in evening
misalignment was found to uniquely predict 3.7% ($p < .05$) of the variance in Time2 DASS scores after controlling for all other variables, and thus, this model did significantly increase the variance accounted for from Step 1, $F(8,77) = 9.46$, $p < .001$, $R^2 = .50$. Change in total circadian misalignment uniquely predicted only 0.6% ($ns$) of the variance in Time2 DASS scores after controlling for all other variables, and thus, this model did not significantly increase the variance accounted for from Step 1, $F(8,76) = 8.57$, $p < .001$, $R^2 = .47$. Overall, the results of the analyses only partially support hypothesis one. Increases in evening misalignment over the course of the term was found to independently predict greater negative emotionality after the effects of sleep and other study variables were accounted for, but morning misalignment and total misalignment did not. The results of this analysis are presented in Table 3.

**Hypothesis Two**

Hypothesis two proposed that the degree of misalignment would predict student adjustment to university, even after controlling for ADHD symptomology, chronotype, and amount of sleep received. Hierarchical linear regression analyses were conducted to predict student adjustment (i.e. the SACQ) at Time2. Step 1 included the same variables initially listed in hypothesis one, (gender, age in months, the ASRS, the MEQ, hours of sleep per week at both Time1 and Time2) plus the Time1 SACQ score. This model was significant, accounting for 36.0% of the variance in Time2 SACQ scores, $F(7,67) = 5.38$, $p < .001$, $R^2 = .36$. Step 2 included the same misalignment variables previously listed.

Change in morning misalignment was found to uniquely predict only 1.1% ($ns$) of the variance in Time2 SACQ scores after controlling for all other variables, and thus, this model did not significantly increase the variance accounted for from step one, $F(8,65) = 4.79$, $p < .001$, $R^2 = .37$. Change in evening misalignment was found to uniquely predict 13.5% ($p < .001$) of the
variance in Time2 SACQ scores after controlling for all other variables, and thus, this model did significantly increase the variance accounted for from step one, $F(8,66) = 8.08, p < .001, R^2 = .50$. Change in total circadian misalignment was found to uniquely predict 3.8% ($p < .05$) of the variance in Time2 SACQ scores after controlling for all other variables, and thus, this model did significantly increase the variance accounted for from step one, $F(8,65) = 5.36, p < .001, R^2 = .40$. Overall, the results of these analyses largely support hypothesis two in that increases in both evening misalignment and total misalignment over the course of the term were found to independently predict poorer adjustment to university after the predictive effects of sleep and other study variables were accounted for, but morning misalignment did not. These results are presented in Table 4.

**Hypothesis Three**

Hypothesis three predicted that the degree of misalignment would predict academic performance in university, even after controlling for ADHD symptomology, chronotype, and amount of sleep received. To test this hypothesis, a series of hierarchical linear regression analyses were conducted to predict academic performance at Time2. In each case, Step 1 included the same variables initially listed in hypothesis one and two, plus the Time1 academic performance score. This model was significant, accounting for 30.1% of the variance in Time2 academic performance, $F(7,81) = 4.98, p < .001, R^2 = .30$. Step 2 included the same misalignment variables previously listed.

Change in morning misalignment did not significantly predict academic performance at Time2 after controlling for Step 1 variables 1.6% (ns), $F(8,79) = 4.58, p < .001, R^2 = .32$. Change in evening misalignment was found to uniquely predict 3.8% ($p < .05$) of the variance in Time2 academic performance after controlling for all other variables, and thus, this model did
significantly increase the variance accounted for from step one, $F(8,80) = 5.13, p < .001, R^2 = .34$. Similarly, change in total circadian misalignment was found to uniquely predict 6.2% ($p < .01$) of the variance in Time2 academic performance after controlling for all other variables, and thus, this model did significantly increase the variance accounted for from step one, $F(8,65) = 5.63, p < .001, R^2 = .36$. Overall, the results of the analyses largely support hypothesis three. Increases in both evening misalignment and total misalignment over the course of the term were found to independently predict poorer academic performance after the predictive effects of sleep and other study variables were accounted for, but morning misalignment did not. The results of this analysis are presented in Table 5.

**Hypothesis Four**

Hypothesis four predicted that ADHD symptomology would not independently predict negative emotionality, adjustment to university, or academic performance after controlling for circadian misalignment and the other predictor variables. To test this hypothesis, a series of hierarchical linear regression models were conducted. In each case, Step 1 included gender, age in months, hours of sleep per week at both Time1 and Time2, the three circadian misalignment measures, and the baseline measure of the dependent variable of interest (i.e. the DASS, SACQ, or Academics at Time1. The ASRS was entered in Step 2.

When predicting negative emotionality (DASS) at Time2, variables entered during Step 1 accounted for 50.6% of the variance, and the model was significant, $F(7,77) = 11.25, p < .001$, $R^2 = .51$. Step 2 did not constitute a significant increase in the variance accounted for from Step 1 as the ASRS was only found to uniquely account for 0.2% (ns) of the variance in negative emotionality. When predicting adjustment to university (SACQ) at Time2, variables entered during Step 1 accounted for 47.6% of the variance, and the model was significant, $F(7,66) =$
8.59, \( p < .001 \), \( R^2 = .48 \). Step 2 did not constitute a significant increase in the variance accounted for from Step 1 as the ASRS was only found to uniquely account for 3.0% (ns) of the variance in student adjustment. When predicting academic performance at Time2, variables entered during Step 1 accounted for 35.9% of the variance, and the model was significant, \( F(7,80) = 6.40, p < .001, \ R^2 = .36 \). Step 2 did not constitute a significant increase in the variance accounted for from Step 1 as the ASRS was only found to uniquely account for 0.4% (ns) of the variance in academic performance. Overall, the results of the analyses support hypothesis four, as ADHD symptomology was not found to independently predict negative emotionality, adjustment to university, or academic performance after the effects of sleep, misalignment, and other study variables were accounted for. The results of this analysis are presented in Table 6.

**Hypothesis Five**

Hypothesis five predicted that chronotype would not independently predict negative emotionality, adjustment to university, or academic performance after controlling for circadian misalignment and the other predictor variables. To test this hypothesis, a series of hierarchical linear regression models were conducted. In each case, Step 1 included gender, age in months, hours of sleep per week at both Time1 and Time2, the three circadian misalignment measures, and the baseline measure of the dependent variable of interest (i.e. the DASS, SACQ, or Academics at Time1). The MEQ was entered in Step 2.

When predicting negative emotionality (DASS) at Time2, variables entered during Step 1 accounted for 50.6% of the variance, and the model was significant, \( F(7,77) = 11.25, p < .001, \ R^2 = .51 \). Step 2 did not constitute a significant increase in the variance accounted for from Step 1 as the MEQ was only found to uniquely account for 0.2% (ns) of the variance in negative emotionality. When predicting adjustment to university (SACQ) at Time2, variables entered
during Step 1 accounted for 47.6% of the variance, and the model was significant, $F(7,66) = 8.55, p < .001, R^2 = .48$. Step 2 did not constitute a significant increase in the variance accounted for from Step 1, as the MEQ was only found to uniquely account for 1.8% ($ns$) of the variance in student adjustment. When predicting academic performance at Time2, variables entered during Step 1 accounted for 35.9% of the variance, and the model was significant, $F(7,80) = 6.40, p < .001, R^2 = .36$. Step 2 did not constitute a significant increase in the variance accounted for from Step 1, with the MEQ only uniquely accounting for 0.4% ($ns$) of the variance in academic performance. Overall, the results of the analyses support hypothesis five as chronotype was not found to independently predict internalizing symptoms, adjustment to university, or academic performance after the predictive effects of sleep, misalignment, and other study variables were accounted for. The results of this analysis are presented in Table 7.

**Discussion**

The goal of this study was to examine the role of circadian misalignment on students’ transition to university. To accomplish this, student self-report of ADHD symptomology and sleep timing preferences was collected in addition to information regarding actual sleep patterns. These predictors were investigated as potential predictors of self-reported negative emotionality, student adjustment to university, and academic performance. Thus, the current study constitutes a novel investigation of circadian misalignment in first year university students, and compared students’ preferred and actual sleep cycles to their academic and social/emotional outcomes. In turn, the present findings inform the body of literature surrounding the complex interplay of intrapersonal factors, sleep patterns, and ability to adapt to student living.

**Misalignment and Student Outcomes**
Analyses revealed that evening misalignment was significantly related to poorer student outcomes during their first term of university. Specifically, as hypothesized, increases in EM over the course of the term predicted more self-reported negative emotionality, poorer adjustment, and weaker academic performance after controlling for ADHD symptoms. These results are particularly relevant to the literature surrounding the role of depression and ADHD symptomology in student transition to university, as they underscore the importance of considering circadian misalignment as a contributor to outcomes in these students. This is important given how vulnerable students with ADHD are known to be during transition to university (e.g., Farrell, 2013; Rawana & Morgan, 2014). Thus, in addition to the impact of hours slept and the presence of ADHD symptomology, the mismatch between actual and preferred sleeping schedules is important when examining students’ ability to adapt to university life.

While evening misalignment was significantly related to poorer student outcomes, morning misalignment was not. Further, EM and MM were not significantly related to one another. This may indicate that EM and MM are very different constructs, pointing to the importance of future research examining EM and MM as separate constructs rather than just examining circadian misalignment as a whole, especially in first-year university student populations. In their study of adults, Simor and colleagues (2015), measured EM and MM as separate constructs, discovering effects opposite to that of the current study. Here, after controlling for chronotype and sleep quantity, MM significantly predicted negative emotionality, but EM did not. Further, MM and EM were here found to be significantly correlated with one another. Other studies (e.g., Diaz-Morales, 2015) have examined correlations between typical rise and bed times and variables such as chronotype and anxiety without quantifying the degree of misalignment experienced, or
calculating EM or MM. Indeed, the majority of studies in this area of research have examined circadian misalignment as a whole construct, without parsing out the differential effects of EM and MM. Based on the results of this study, and the paucity of research calculating EM and MM, it is clear that failing to look at misalignment in parts rather than just overall might mask important relationships.

**ADHD Symptomology and Student Outcomes**

As predicted by hypothesis four, ADHD symptomology was not related to student outcomes during their first term of university study after the predictive effects of circadian misalignment and hours of sleep were controlled for. Given that the current study is unique in including misalignment as a predictor of student outcomes, these results provide novel insights previously unavailable in the literature examining the relation of ADHD symptoms to student outcomes during university transition. Despite establishing robust relations between ADHD symptoms and sleep difficulties (e.g. Corkum, Tannock, & Moldofsky, 1998), literature has yet to examine how circadian misalignment factors into the sleep problems and other difficulties students with ADHD symptoms encounter. After controlling for hours slept and degree of misalignment experienced, self-reported ADHD symptoms were no longer predictive of negative emotionality, poor adjustment, or poor academics. In light of these results, misalignment of a student’s actual and preferred sleep schedules (and especially their bed time) may in fact contribute to their difficulties to an even greater degree than do their actual ADHD symptoms.

In the present study, ADHD symptomology and academic performance did not have a significant relationship, which is surprising and differs from findings from other studies (e.g., Farrell, 2013). The unique nature of this sample composed entirely of university students may have contributed to this finding as these students have achieved academic success to gain
entrance to university despite ADHD symptoms. Thus, they may represent a subset of individuals with higher ADHD symptoms who have learned to overcome these symptoms in an academic context and are not typical of the broader distribution of individuals with ADHD. As well, females with ADHD symptomology may differ systematically from males, as the study was predominantly female (90%). Most published research investigating how students with ADHD adjust to university, perform academically, and experience sleep includes more gender balanced samples (e.g., Bae et al., 2010; Barry, Lyman, & Klinger, 2002). Thus, the findings of this research are potentially more relevant to understanding adjustment in relatively high achieving, female students with ADHD rather than all students. Further research will be needed in order to determine if the degree of misalignment – not the severity of the ADHD symptoms – is what accounts for poor student outcomes in a broader sample.

Strengths and Limitations

The strength of the current study includes its examination of the separate and combined effects of CM on adjustment to university in first year students. The sample size enabled detection of large effects. As this study included the investigation of the novel variable of circadian misalignment, it provides preliminary effect sizes and confidence intervals which can inform future studies. In addition, the study included both ADHD symptoms and the key predictors of adjustment identified in the research literature and thus it extends our understanding of university transition for potentially vulnerable students.

Limitations include the uneven gender distribution, and the reliance on self-report data. Future research should aim to increase generalizability of study results by having a more even gender distribution, and by exploring the variables of interest in individuals who meet diagnostic criterion for ADHD. The latter group may differ qualitatively from those who have some
elevated symptoms but do not meet full diagnostic criteria and the relationships between circadian misalignment and adjustment demonstrated in this study may or may not apply to them.

Additionally, the current study relied on self-reported measures of sleep quantity and timing. This approach has been taken in the majority of previous studies in this area of literature (e.g., Diaz-Morales 2015; Simor et al., 2015). A few articles have compared self-report sleep measures to objective sleep measures and found significant correlations between the two (e.g., Lauderdale et al., 2008; Wolfson et al., 2002). However, the use of self-reported measures of sleep is still a limitation worth noting.

**Future Research**

Future research should aim to increase the validity of the study design by implementing objective measures of sleep quality and quantity (e.g. by using Fitbits or actigraphs to track sleep) and employing a multi-method procedure.

As noted above, future research would benefit from inclusion of a broader undergraduate sample that is gender balanced to determine if the findings of this sample apply more generally. In addition, given the unique role of circadian misalignment on adjustment revealed in this study, it would be interesting to examine its role on other areas of adjustment or difficulties encountered by individuals with ADHD outside of the university context.

Since EM was significantly related to poorer student outcomes, and MM was not, the results of the study highlight the importance of future research examining EM and MM as separate constructs rather than just examining circadian misalignment as a whole. Some (e.g. Simor et al., 2015) have already begun to research in this way.
Taken together, the results of this study have noteworthy implications for the current structure of university class schedules. Specifically, in adjusting the scheduling of classes there exists a possibility of an intervention that targets the vulnerable student population of individuals with ADHD. In a qualitative study of post-secondary students with ADHD, Meaux, Green, & Broussard (2009) found that the most frequent barrier to academic success reported by students was failing to wake up on time for classes. In light of the current results, considering having required courses for degree programs offered at different times of day (e.g. afternoon or evening classes) may help mitigate this problem by enabling students with ADHD to adhere more closely to their preferred sleep schedule while still being able to attend required courses. Thus, this study may be informative in designing support and accommodations for students with high ADHD symptoms to maximize their likelihood of successfully transitioning to university.
References


Table 1

*Means and standard deviations for study variables as a function of gender*

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<td>SD</td>
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*Note. M and SD represent mean and standard deviation, respectively.*

*Levene’s violated (F = 6.77, p = .011). Reported equal variances not assumed value.*

**Levene’s violated, (F = 4.47, p = .037). Reported equal variances not assumed value.*
Table 2

**Correlations, means, and standard deviations of study variables**

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<td>-.080</td>
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<td>.707**</td>
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<td>.017</td>
<td>.199</td>
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<td>.069</td>
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<td>.686**</td>
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<td>.006</td>
<td>-.169</td>
<td>-.115</td>
<td>-.105</td>
<td>.030</td>
<td>-.061</td>
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</tbody>
</table>

*Notes. M and SD represent the mean and standard deviation, respectively. * indicates p < .05, ** indicates p < .001*
Table 3

Summary of Hierarchical Regression Analysis for Variables Predicting Internalizing Symptoms at Time2 (DASS; N = 85)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th></th>
<th></th>
<th>Model 2</th>
<th></th>
<th></th>
<th>Model 3</th>
<th></th>
<th></th>
<th>Model 4</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
</tr>
<tr>
<td>Age</td>
<td>-.01 [-.03, .01]</td>
<td>.01</td>
<td>-.08</td>
<td>-.01 [-.03, .01]</td>
<td>.01</td>
<td>-.08</td>
<td>-.01 [-.03, .01]</td>
<td>.01</td>
<td>-.07</td>
<td>-.01 [-.03, .01]</td>
<td>.01</td>
</tr>
<tr>
<td>Gender</td>
<td>-.13 [-.55, .29]</td>
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<td>-.06</td>
<td>-.18 [-.60, .25]</td>
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<td>-.08</td>
<td>-.14 [-.55, .26]</td>
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<td>-.06</td>
<td>-.11 [-.53, .31]</td>
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<td>.03</td>
<td>.06 [-.23, .35]</td>
<td>.15</td>
<td>.04</td>
<td>.11 [-.18, .40]</td>
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<td>.08</td>
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<td>.05</td>
<td>.12 [-.26, .49]</td>
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<td>.06</td>
<td>.14 [-.22, .51]</td>
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<td>.07</td>
<td>.11 [-.27, .48]</td>
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<td>DASSTime1</td>
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<td>.70</td>
<td>.86 [.60, 1.12]</td>
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<td>.70</td>
<td>.84 [.59, 1.10]</td>
<td>.13</td>
<td>.68</td>
<td>.87 [.61, 1.13]</td>
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<tr>
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<td>.01</td>
<td>-.09</td>
<td>-.01 [-.03, .02]</td>
<td>.01</td>
<td>-.06</td>
<td>-.02 [-.04, .01]</td>
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<td>-.01 [-.04, .01]</td>
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<td>.02 [.00, .04]</td>
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<td>Δ in MM</td>
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<td>-.11</td>
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<td>.03 [.01, .05]</td>
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<tr>
<td>Δ in EM</td>
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<tr>
<td>Δ in CM</td>
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<td>.09</td>
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<td>.48 [.26, .56]</td>
<td>.50 [.28, .58]</td>
<td>.47 [.25, .55]</td>
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<tr>
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*p > .05. **p >.01. *** is p > .001.
Table 4

*Summary of Hierarchical Regression Analysis for Variables Predicting Student Adjustment to University at Time2 (SACQ; N = 74)*

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<th>Variable</th>
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<th>Model 2</th>
<th></th>
<th></th>
<th>Model 3</th>
<th></th>
<th></th>
<th>Model 4</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
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<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
</tr>
<tr>
<td>Age</td>
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<td>-.01</td>
<td>.00 [-.03, .03]</td>
<td>.01</td>
<td>-.01</td>
<td>.00 [-.03, .03]</td>
<td>.01</td>
<td>.00</td>
<td>.00 [-.03, .03]</td>
<td>.02</td>
</tr>
<tr>
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<td>-.03</td>
<td>-.08 [-.89, .72]</td>
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<td>-.02</td>
<td>-.17 [-.89, .56]</td>
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<td>-.14 [-.92, .65]</td>
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<td>-.12</td>
<td>-.23 [-.65, .20]</td>
<td>.21</td>
<td>-.14</td>
<td>-.24 [-.62, .24]</td>
<td>.19</td>
<td>-.15</td>
<td>-.19 [-.60, .22]</td>
<td>.21</td>
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<tr>
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<td>.09</td>
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<td>.08</td>
<td>-.20 [-.34, .73]</td>
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<td>.08</td>
<td>-.24 [-.34, .83]</td>
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<td>.48</td>
<td>.47 [.28, .66]</td>
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<td>.50</td>
<td>.49 [.28, .70]</td>
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<td>-.03</td>
<td>-.01 [-.05, .03]</td>
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<td>-.05</td>
<td>-.02 [-.02, .05]</td>
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<tr>
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<tr>
<td>Δ in CM</td>
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<td>-.03 [-.05, .00]</td>
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<td>.37 [.12, .46]</td>
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<td>.50 [.26, .58]</td>
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<tr>
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<td>17.38***</td>
<td>17.38***</td>
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<td>4.09*</td>
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*p > .05. **p > .01. *** is p > .001.
Table 5

Summary of Hierarchical Regression Analysis for Variables Predicting Student Academic Performance at Time2 (SACQ; N = 88)

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<tr>
<th>Variable</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
<td>B [95% CI]</td>
</tr>
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<td>0.02</td>
<td>-0.17</td>
<td>-0.03 [-0.06, 0.00]</td>
<td>0.02</td>
<td>-0.17</td>
<td>-0.03 [-0.07, 0.00]</td>
<td>0.02</td>
<td>-0.18</td>
<td>-0.03 [-0.06, 0.00]</td>
</tr>
<tr>
<td>Gender</td>
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<td>0.01</td>
<td>-0.08 [-0.77, 0.61]</td>
<td>0.35</td>
<td>-0.02</td>
<td>0.05 [-0.62, 0.71]</td>
<td>0.33</td>
<td>0.01</td>
<td>-0.10 [-0.76, 0.55]</td>
</tr>
<tr>
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<td>-0.02</td>
<td>-0.02 [-0.43, 0.39]</td>
<td>0.20</td>
<td>-0.01</td>
<td>-0.10 [-0.50, 0.30]</td>
<td>0.20</td>
<td>-0.06</td>
<td>-0.07 [-0.46, 0.33]</td>
</tr>
<tr>
<td>MEQ</td>
<td>0.17 [-0.45, 0.79]</td>
<td>0.31</td>
<td>0.06</td>
<td>0.20 [-0.42, 0.81]</td>
<td>0.31</td>
<td>0.07</td>
<td>0.10 [-0.50, 0.71]</td>
<td>0.30</td>
<td>0.04</td>
<td>0.14 [-0.45, 0.73]</td>
</tr>
<tr>
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<td>0.51</td>
<td>0.83 [0.50, 1.16]</td>
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<td>0.50</td>
<td>0.83 [0.51, 1.16]</td>
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<td>0.50</td>
<td>0.80 [0.49, 1.12]</td>
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<td>0.00 [-0.04, 0.04]</td>
<td>0.02</td>
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<td>0.02</td>
<td>0.03</td>
<td>0.01 [-0.03, 0.05]</td>
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<td>HrsSleepTime2</td>
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<td>-0.03</td>
<td>0.00 [-0.04, 0.03]</td>
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<td>0.00 [-0.04, 0.03]</td>
<td>0.02</td>
<td>-0.04</td>
<td>-0.01 [-0.05, 0.02]</td>
</tr>
<tr>
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<td>-0.14</td>
<td>-0.04 [-0.07, 0.00]</td>
<td>0.02</td>
<td>-0.20</td>
<td>-0.04 [-0.06, 0.01]</td>
<td>0.01</td>
<td>-0.27</td>
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<tr>
<td>Δ in EM</td>
<td></td>
<td></td>
<td></td>
<td>-0.04 [-0.06, 0.01]</td>
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<td>-0.04 [-0.06, 0.01]</td>
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<tr>
<td>$R^2$ [95% CI]</td>
<td>0.30 [0.09, 0.39]</td>
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<td></td>
<td>0.32 [0.10, 0.40]</td>
<td></td>
<td></td>
<td>0.34 [0.12, 0.43]</td>
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<td>0.36 [0.14, 0.45]</td>
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<tr>
<td>$F$ for Δ$R^2$</td>
<td>4.93***</td>
<td>1.82</td>
<td></td>
<td>4.61*</td>
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<td></td>
<td>7.66**</td>
<td></td>
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*p > .05. **p > .01. *** is p > .001.
Table 6

Summary of Hierarchical Regression Analysis for ADHD Symptomology as a Predictor of Student Outcomes at Time2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: DASSTime2</th>
<th>Model 2: SACQ Time2</th>
<th>Model 3: AcademicTime2</th>
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<tbody>
<tr>
<td>Age</td>
<td>-.01 [-.03, .01]</td>
<td>.01 -.05 -65</td>
<td>.00 [-.03, .03]</td>
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<tr>
<td>Gender</td>
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<td>HrsSleepTime1</td>
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<td>.01 [-.02, .05]</td>
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<td>HrsSleepTime2</td>
<td>.02 [.00, .04]</td>
<td>.01 .21 1.77</td>
<td>-.02 [-.05, .01]</td>
</tr>
<tr>
<td>Δ in MM</td>
<td>-.01 [-.03, .01]</td>
<td>.01 -.08 -87</td>
<td>.02 [.01, .06]</td>
</tr>
<tr>
<td>Δ in EM</td>
<td>.02 [.00, .04]</td>
<td>.01 .19 2.19*</td>
<td>-.07 [-.10, -.04]</td>
</tr>
<tr>
<td>DASSTime1</td>
<td>.83 [.58, 1.08]</td>
<td>.13 .67 6.56***</td>
<td></td>
</tr>
<tr>
<td>SACQTime1</td>
<td></td>
<td>.46 [.27, .65]</td>
<td>.10 .49 4.83***</td>
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<td>.16 .49 5.16***</td>
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<td>.51</td>
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*p > .05. **p > .01. *** is p > .001.
Table 7

Summary of Hierarchical Regression Analysis for Chronotype as a Predictor of Student Outcomes at Time2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: DASSTime2</th>
<th>Model 2: SACQ Time2</th>
<th>Model 3: AcademicTime2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B [95% CI]</td>
<td>SE B</td>
<td>β</td>
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<td>Age</td>
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<td>0.01</td>
<td>-0.07</td>
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<td>Gender</td>
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<td>HrsSleepTime2</td>
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<td>0.01</td>
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<td>Δ in MM</td>
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<td>0.53</td>
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<td>MEQ</td>
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<tr>
<td>$F$ for $ΔR^2$</td>
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<td>2.28</td>
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</table>

*p > .05. **p > .01. *** is p > .001.
Appendix A

The Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist

Instructions:

Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months.

Response Options:

a. Never
b. Rarely
c. Sometimes
d. Often
e. Very Often

Part A:

1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?
2. How often do you have difficulty getting things in order when you have to do a task that requires organization?
3. How often do you have problems remembering appointments or obligations?
4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started?
5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?
6. How often do you feel overly active and compelled to do things, like you were driven by a motor?

Part B:

7. How often do you make careless mistakes when you have to work on a boring or difficult project?

8. How often do you have difficulty keeping your attention when you are doing boring or repetitive work?

9. How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly?

10. How often do you misplace or have difficulty finding things at home or at work?

11. How often are you distracted by activity or noise around you?

12. How often do you leave your seat in meetings or other situations in which you are expected to remain seated?

13. How often do you feel restless or fidgety?

14. How often do you have difficulty unwinding and relaxing when you have time to yourself?

15. How often do you find yourself talking too much when you are in social situations?

16. When you’re in a conversation, how often do you find yourself finishing the sentences of the people you are talking to, before they can finish them themselves?

17. How often do you have difficulty waiting your turn in situations when turn taking is required?

18. How often do you interrupt others when they are busy?
Appendix B

The Morningness-Eveningness Questionnaire (MEQ)

Instructions:

1. Please read each question very carefully before answering.

2. Answer ALL questions.

3. Answer questions in numerical order.

4. Each question should be answered independently of others. Do NOT go back and check your answers.

5. All questions have a selection of answers. For each question place a cross alongside ONE answer only. Some questions have a scale instead of a selection of answers. Place a cross at the appropriate point along the scale.

6. Please answer each question as honestly as possible. Both your answers and the results will be kept in strict confidence.

7. Please feel free to make any comments in the section provided below each question.

Items:

1. Considering only your own “feeling best” rhythm, at what time would you get up if you were entirely free to plan your day?

<table>
<thead>
<tr>
<th>5AM</th>
<th>6AM</th>
<th>7AM</th>
<th>8AM</th>
<th>9AM</th>
<th>10AM</th>
<th>11AM</th>
<th>12PM</th>
</tr>
</thead>
</table>

2. Considering only your own “feeling best” rhythm, at what time would you go to bed if you were entirely free to plan your evening?

3. If there is a specific time at which you have to get up in the morning, to what extent are you dependent on being woken up by an alarm clock?
   a. Not at all dependently
   b. Slightly dependent
   c. Fairly dependent
   d. Very dependent

4. Assuming adequate environmental conditions, how each do you find getting up in the mornings?
   a. Not at all easy
   b. Not very easy
   c. Fairly easy
   d. Very easy

5. How alert do you feel during the first half hour after having woken up in the mornings?
   a. Not at all alert
   b. Slightly alert
   c. Fairly alert
   d. Very alert

6. How is your appetite during the first half-hour after having woken in the mornings?
   a. Very poor
b. Fairly poor

c. Fairly good

d. Very good

7. During the first half-hour after having woken in the morning, how tired do you feel?
   a. Very tired
   b. Fairly tired
   c. Fairly refreshed
   d. Very refreshed

8. When you have no commitments the next day, at what time do you go to bed compared to your usual bedtime?
   a. Seldom or never later
   b. Less than one hour later
   c. 1-2 hours later
   d. More than 2 hours later

9. You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is between 7-8AM. Bearing in mind nothing else but your own “feeling best” rhythm, how do you think you would perform?
   a. Would be on good form
   b. Would be on reasonable form
   c. Would find it difficult
   d. Would find it very difficult
10. At what time in the evening do you feel tired, and as a result, in need of sleep?

![Graph showing time from 8PM to 3AM]

11. You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day and considering only your own “feeling best” rhythm, which ONE of the four testing times would you choose?
   a. 8:00AM to 10:00AM
   b. 11:00AM to 1:00PM
   c. 3:00PM to 5:00PM
   d. 7:00PM to 9:00PM

12. If you went to bed at 11:00PM, at what level of tiredness would you be?
   a. Not at all tired
   b. A little tired
   c. Fairly tired
   d. Very tired

13. For some reason you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which ONE of the following events are you most likely to experience?
   a. Will wake up at usual time and will NOT fall asleep
   b. Will wake up at usual time and will dose thereafter
   c. Will wake up at usual time but will fall asleep again
d. Will NOT wake up until later than usual

14. One night you have to remain awake between 4-6AM in order to carry out a night watch. You have no commitments the next day. Which ONE of the following alternatives will suit you best?
   
a. Would NOT go to bed until watch was over
   
b. Would take a nap before and sleep after
   
c. Would take a good sleep before and a nap after
   
d. Would take ALL sleep before watch

15. You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own “feeling best” rhythm, which ONE of the following times would you choose?
   
a. 8:00AM to 10:00AM
   
b. 11:00AM to 1:00PM
   
c. 3:00PM to 5:00PM
   
d. 7:00PM to 9:00PM

16. You have decided to engage in hard physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is between 10-11PM. Bearing in mind nothing else but your own “feeling best” rhythm, how do you think you would perform?
   
a. Would be on good form
   
b. Would be on reasonable form
   
c. Would find it difficult
   
d. Would find it very difficult
17. Suppose that you can choose your own work hours. Assume that you worked a FIVE hour day (including beaks) and that your job was interesting and paid by results. Which FIVE CONSECUTIVE HOURS would you select?

![Time Chart]

18. At what time of the day do you think that you reach your “feeling best” peak?

![Time Chart]

19. One hears about “morning” and “evening” types of people. Which ONE of these types do you consider yourself to be?

a. Definitely a “morning” type
b. Rather more a “morning” type than an “evening” type
c. Rather more a “evening” type than an “morning” type
d. Definitely an “evening” type
Appendix C

Circadian Misalignment Questions

1. Considering your typical weekday (during your Fall term), at what time do you normally wake up in the morning?

2. Considering your typical weekday (during your Fall term), at what time do you normally fall asleep at night?

3. Considering your typical weekday (during your Fall term), after you go to bed at night, how many hours do you typically spend awake before you wake up in the morning to start your day?
   
   ____ hours and ____ minutes

4. Considering your typical weekend (during your Fall term), at what time do you normally wake up in the morning?
5. Considering your typical weekend (during your Fall term), at what time do you normally fall asleep at night?

6. Considering your typical weekend (during your Fall term), after you go to bed at night, how many hours do you typically spend awake before you wake up in the morning to start your day?

   _____ hours and _____ minutes

7. Do you ever take naps? YES / NO

   a. (If yes): On average, how many times a week do you nap? _____ naps per week

   b. (If yes): On average, how long are your naps? _____ hours and _____ minutes
Appendix D

Depression Anxiety Stress Scales

Instructions:

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

Response Options:

0  Did not apply to me at all
1  Applied to me to some degree, or some of the time
2  Applied to me to a considerable degree, or a good part of time
3  Applied to me very much, or most of the time

Items:

1.  I found myself getting upset by quite trivial things
2.  I was aware of dryness of my mouth
3.  I couldn't seem to experience any positive feeling at all
4.  I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)
5.  I just couldn't seem to get going
6.  I tended to over-react to situations
7.  I had a feeling of shakiness (eg, legs going to give way)
8.  I found it difficult to relax
9.  I found myself in situations that made me so anxious I was most relieved when they ended
10. I felt that I had nothing to look forward to
11. I found myself getting upset rather easily
12. I felt that I was using a lot of nervous energy
13. I felt sad and depressed
14. I found myself getting impatient when I was delayed in any way (eg, lifts, traffic lights, being kept waiting)
15. I had a feeling of faintness
16. I felt that I had lost interest in just about everything
17. I felt I wasn't worth much as a person
18. I felt that I was rather touchy
19. I perspired noticeably (eg, hands sweaty) in the absence of high temperatures or physical exertion
20. I felt scared without any good reason
21. I felt that life wasn't worthwhile
22. I found it hard to wind down
23. I had difficulty in swallowing
24. I couldn't seem to get any enjoyment out of the things I did
25. I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)
26. I felt down-hearted and blue
27. I found that I was very irritable
28. I felt I was close to panic
29. I found it hard to calm down after something upset me
30. I feared that I would be "thrown" by some trivial but unfamiliar task
31. I was unable to become enthusiastic about anything
32. I found it difficult to tolerate interruptions to what I was doing
33. I was in a state of nervous tension
34. I felt I was pretty worthless
35. I was intolerant of anything that kept me from getting on with what I was doing
36. I felt terrified
37. I could see nothing in the future to be hopeful about
38. I felt that life was meaningless
39. I found myself getting agitated
40. I was worried about situations in which I might panic and make a fool of myself
41. I experienced trembling (eg, in the hands)
42. I found it difficult to work up the initiative to do things
Appendix E

The Student Adaptation to College Questionnaire (SACQ)

Instructions:

The 67 statements on this form describe college experiences. Read each one and decide how well it applies to you at the present time (within the past few days). For each statement, select the asterisk at the point in the continuum that best represents how closely the statement applies to you. Select only one asterisk for each statement.

Response Options:

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<th>Doesn’t apply to me at all</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>9</th>
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<tbody>
<tr>
<td>Applies very closely to me</td>
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<td></td>
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<td></td>
<td></td>
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</tr>
</tbody>
</table>

Items:

1. I feel that I fit in well as part of the college environment.
2. I have been feeling tense or nervous lately.
3. I have been keeping up to date on my academic work.
4. I am meeting as many people, and making as many friends as I would like at college.
5. I know why I’m in college and what I want out of it.
6. I am finding academic work at college difficult.
7. Lately, I have been feeling blue and moody a lot.
8. I am very involved with social activities in college.
9. I am adjusting well to college.
10. I have not been functioning well during examinations.
11. I have felt tired much of the time lately.
12. Being on my own, taking responsibility for myself, has not been easy.
13. I am satisfied with the level at which I am performing academically.
14. I have had informal, personal contacts with college professors.
15. I am pleased now about my decision to go to college.
16. I am pleased now about my decision to attend this college in particular.
17. I’m not working as hard as I should at my course work.
18. I have several close social ties at college.
19. My academic goals and purposes are well defined.
20. I haven’t been able to control my emotions very well lately.
21. I’m not really smart enough for academic work I am expected to be doing now.
22. Lonesomeness for home is a source of difficulty for me now.
23. Getting a college degree is very important for me.
24. My appetite has been good lately.
25. I haven’t been very efficient in the use of study time lately.
26. I enjoy living in a college dormitory. (Please omit if you do not live in a dormitory; any university housing should be regarded as a dormitory.)
27. I enjoy writing papers for courses.
28. I have been having a lot of headaches lately.
29. I really haven’t had much motivation for studying lately.
30. I am satisfied with the extracurricular activities available at college.
31. I’ve given a lot of thought lately to whether I should ask for help from the Psychological/Counseling Services Center or from a psychotherapist outside of college.
32. Lately, I have been having doubts regarding the value of a college education.
33. I am getting along very well with my roommate(s) at college. (Please omit if you do not have a roommate.)
34. I wish I were at another college or university.
35. I’ve put on (or lost) too much weight recently.
36. I am satisfied with the number and variety of courses available at college.
37. I feel that I have enough social skills to get along well in the college setting.
38. I have been getting angry too easily lately.
39. Recently I have had trouble concentrating when I try to study.
40. I haven’t been sleeping very well.
41. I’m not doing well enough academically for the amount of work I put in.
42. I am having difficulty feeling at ease with other people at college.
43. I am satisfied with the quality or the caliber of courses available at college.
44. I am attending classes regularly.
45. Sometimes my thinking gets muddled up too easily.
46. I am satisfied with the extent to which I am participating in social activities at college.
47. I expect to stay at this college for a bachelor’s degree.
48. I haven’t been mixing too well with the opposite sex lately.
49. I worry a lot about my college expenses.
50. I am enjoying my academic work at college.
51. I have been feeling lonely a lot at college lately.
52. I am having a lot trouble getting started on homework assignments.
53. I feel I have good control over my life situation at college.
54. I am satisfied with my program of courses for this semester/quarter.
55. I have been feeling in good health lately.
56. I feel I am very different from other students at college in ways that I don’t like.
57. On balance, I would rather be home than here.
58. Most of the things I am interested in are not related to any of my course work at college.
59. Lately I have been giving a lot of thought to transferring to another college.
60. Lately I have been giving a lot thought to dropping out of college altogether and for good.
61. I find myself giving considerable thought to taking time off from college and finishing later.
62. I am very satisfied with the professors I have now in my courses.
63. I have some good friends or acquaintances at college with whom I can talk about any problems I may have.
64. I am experiencing a lot of difficulty coping with the stresses imposed upon me in college.
65. I am quite satisfied with my social life at college.
66. I’m quite satisfied with my academic situation at college.
67. I feel confident that I will be able to deal in a satisfactory manner with future challenges here at college.
Appendix F

Academic Performance (Part 1)

Instructions:

Please answer the following question about your previous academic performance.

Item:

1. In general, what type of grades did you typically receive in your last two years of high school?
   
   a. Below 50%
   b. Between 50-60%
   c. Between 60-70%
   d. Between 70-80%
   e. Between 80-90%
   f. Above 90%
Academic Performance (Part 2)

Instructions:

Please answer the following question about your current academic performance.

Item:

1. In general, what type of grades have you been receiving since attending University of Guelph?
   
   a. Below 50%
   
   b. Between 50-60%
   
   c. Between 60-70%
   
   d. Between 70-80%
   
   e. Between 80-90%
   
   f. Above 90%
Appendix G

Additional Questions

1. Have you ever been diagnosed with any of the following? (Check all that apply):
   a. ADHD
   b. Learning Disability
   c. Mood Disorder (ex. Anxiety, Depression, etc.)
   d. Sleep Disorder

2. Are you currently taking any of the following medications or supplements? (Check all that apply):
   a. Stimulant medications (Adderall, Vyvanse, Strattera, Concerta, Ritalin, etc.)
   b. Any other medication intended to treat ADHD
   c. Any medication or supplement intended to help with sleep (e.g. Melatonin, sleeping pills)
   d. Any other medications
      i. If yes, do you feel this medication impacts your sleep? (Yes or No)

      If yes, please indicate the name(s) of the medication or supplement:

      ____________________________________________________________
      ____________________________________________________________
Appendix H

Certificate of Approval from the University of Guelph Research Ethics Board

RESEARCH ETHICS BOARDS
Certification of Ethical Acceptability of Research Involving Human Participants

<table>
<thead>
<tr>
<th>APPROVAL PERIOD:</th>
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</tr>
</thead>
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<tr>
<td>PRINCIPAL INVESTIGATOR:</td>
<td>Young, Arlene (<a href="mailto:ayoung09@uoguelph.ca">ayoung09@uoguelph.ca</a>)</td>
</tr>
<tr>
<td>DEPARTMENT:</td>
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<td>SPONSOR(S):</td>
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<td>TITLE OF PROJECT:</td>
<td>Student Adjustment to University: Impact of Circadian Misalignment, ADHD Symptomology and Eveningness Chronotype</td>
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The members of the University of Guelph Research Ethics Board have examined the protocol which describes the participation of the human participants in the above-named research project and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement, 2nd Edition.

The REB requires that researchers:
- Adhere to the protocol as last reviewed and approved by the REB.
- Receive approval from the REB for any modifications before they can be implemented.
- Report any change in the source of funding.
- Report unexpected events or incidental findings to the REB as soon as possible with an indication of how these events affect, in the view of the Principal Investigator, the safety of the participants, and the continuation of the protocol.
- Are responsible for ascertaining and complying with all applicable legal and regulatory requirements with respect to consent and the protection of privacy of participants in the jurisdiction of the research project.

The Principal Investigator must:
- Ensure that the ethical guidelines and approvals of facilities or institutions involved in the research are obtained and filed with the REB prior to the initiation of any research protocols.
- Submit a Status Report to the REB upon completion of the project. If the research is a multi-year project, a status report must be submitted annually prior to the expiry date. Failure to submit an annual status report will lead to your study being suspended and potentially terminated.

The approval for this protocol terminates on the EXPIRY DATE, or the term of your appointment or employment at the University of Guelph whichever comes first.

Signature:  
Date: September 22, 2016

Stephen P. Lewis  
Chair, Research Ethics Board-General

L. Vallis  
Chair, Research Ethics Board-NPES
Appendix I

Email Script Inviting Participants to Enter Time2 Data

Hello,

You are receiving this email because you participated in the study “Adjustment to University: Impacts of Misalignment, Eveningness, & ADHD” in September. We greatly appreciate your involvement in this research, and we now request that you participate in part two (in addition to course credit, you will now also be entered into a draw for a gift card). As indicated in the September consent form, we are now contacting you for part two of the study. This part of the study is essential and critical for the research project.

Timeslots for participation in the study “**PART TWO - Student Adjustment to University: Impacts of Misalignment, Eveningness, & ADHD” are now available. This study is worth 0.5 credits and will provide you with a link in order to answer questions which are mostly repeated from the survey in September. It should take less than 25 minutes to complete.

In addition to course credit, you will be entered into a draw to win one of five $25.00 gift card to the University of Guelph bookstore. After submitting your responses, you will be given the opportunity to provide your email address and indicate that you wish to be entered into the draw. Odds of winning are greater than 1/32, and the draw will occur on December 5th (data collection though the SONA system must be completed by December 2nd). Only winners will be contacted and told where to pick up their prize, and all email addresses will be destroyed after the draw.

In summary, if you still course credits to acquire through SONA, click on the “**PART TWO - Student Adjustment to University: Impacts of Misalignment, Eveningness, & ADHD.” study on the active studies link click to sign up for a time slot. If you no longer need course credit, please complete the study by clicking on the following link: https://uoguelph.eu.qualtrics.com/SE/?SID=SV_b8ILVHp4uvpD3T.

Once again, thank you for your participation in this research!

Regards,

Larissa Panetta

OCT, BEd, BScH, BAH
Appendix J

Consent Form

Q1.1
CONSENT TO PARTICIPATE IN
RESEARCH
Student Adjustment to University: Impact of
Circadian Misalignment, ADHD
Symptomology and Eveningness
Chronotype

You are asked to participate in a research study conducted by Larissa Panetta, a student completing her Masters Thesis and Dr. Arlene Young, research supervisor from the psychology department at the University of Guelph. If you have any questions or concerns about the research, please feel free to contact Larissa Panetta at lpanetta@uoguelph.ca, or Dr. Young at ayoung09@uoguelph.ca.

PURPOSE OF THE STUDY
This study will examine the relationship between sleep quantity, preferred versus actual sleep schedules, and problems with attention or restlessness that are often found in the general population. We are also interested in your adjustment to university during your first term of study.

PARTICIPATION
In order to participate in this study you must be a first year undergraduate student between the ages of 17-21 (inclusive). In addition, you must not be living at home with your parents or guardians (e.g. you are living in residence or living in shared student housing).

PROCEDURES
If you volunteer to participate in this study, we ask you to do the following things:

Participation requires the completion of two separate internet surveys to be completed over the course of the Fall 2016 term. The experiment consists of three parts. First, you will be provided with a link and asked to complete a survey which will take about 30 minutes to complete. About two months later, you will be provided with another link and asked to complete another survey. This survey will repeat some of the questions asked in the first part of the study and will take about 25 minutes to complete. If you choose to provide your email address to be contacted for a follow-up study, you will be provided a third link and invited to participate after the fall term. This
individual survey responses to your name or email unless you include your pool ID number in an email to the research team.

After the completion of part two of the study, participants will be given the option to provide their email address in order to be contacted for a follow-up study and subsequent draw for a $50 University of Guelph Bookstore gift card. Email addresses that are provided at the end of part two of the study will be downloaded into a separate document, and therefore will not be linked to survey responses in any way. This list of emails will be held on a secure server only accessible by the research team. In January 2017, the entire list of collected emails will be sent a link to participate in the optional follow-up. Once all follow-up data is collected, a draw will be held, and the winner of the draw will be notified via email. At this point, the list of emails will be destroyed. Names and email addresses are not used in this data set and no other personally identifiable information will be collected from you. You will not be contacted by email for any reason except for invitation to participate in the January 2017 follow-up, or if you win a gift card. Your email address will not be retained after January 2017.

PARTICIPATION AND WITHDRAWAL
Your participation in this study is completely voluntary. You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind by exiting the browser. You may also refuse to answer any questions you don’t want to answer and still remain in the study. You may exercise the option of removing your data from the study by contacting the student investigator at ipanetta@uoguelph.ca and providing your Pool ID number. Please note that providing your Pool ID number would be the only way to identify your responses if you wish to have them removed The investigator may withdraw you from this research if circumstances arise that warrant doing so. Please note that if you decide not to participate or withdraw from the study at any time, your grade in the course will not be affected.

RIGHTS OF RESEARCH PARTICIPANTS
This project has been reviewed by the University of Guelph Research Ethics Board for compliance with federal guidelines for research involving human participants. If you have any questions regarding your rights and welfare as a research participant in this study (REB #16AU036), please contact:

Director, Research Ethics
University of Guelph
rebe@uoguelph.ca
519-824-4120 ext. 56606

You do not waive any legal rights by agreeing to take part in this study.

Please PRINT AND/OR SAVE this page for your records before choosing one of the following options:

☒ I have read the information provided for the study "Student Adjustment to University: Impact of Circadian Misalignment, ADHD Symptomology and Eveningness Chronotype" as described herein, and I agree to participate in this study. (1)
☒ I do not agree to participate in this study. (2)
Appendix K

Debriefing Form

Q8.1 Information Letter

The purpose of this research is to determine if the relationship between sleep quantity, preferred versus actual sleep schedules, and inattentive and hyperactive traits found in the general population have an impact on student adjustment to university during their first term of study. There is growing evidence that the mismatch between the preferred and actual timing of one's sleep schedule has an impact on well-being that goes over and above the amount of sleep or quality of sleep received. Individuals with a greater degree of ADHD symptomology are known to prefer a later sleep schedule, and thus tend to experience a greater mismatch between preferred and actual sleep schedules. In their milder form, inattentive and hyperactive traits are seen in the general population and they are not indicative of clinical ADHD. The scale you completed was the Adult ADHD Self-Report Scale, a survey to determine the extent to which individuals in the general population show inattentive and/or hyperactive traits. The information you provided today helps us determine if associations exist between these inattentive and hyperactive traits and preferred sleep timing in people who do not necessarily have a diagnosis of ADHD.

Your generosity and willingness to participate in this study are greatly appreciated. Through this research we hope to develop a better understanding of the association between sleep timing variables, inattentive and hyperactive traits, and adjustment to university. Please note that the Adult ADHD Self-Report Scale is not a diagnostic tool for ADHD and scores on this measure do not indicate if someone has ADHD or not. If participating in this study led you to feel distressed and you would like to speak to someone about your thoughts and emotions, please contact one of the following:

University of Guelph’s counselling services is located on the 3rd floor of the University Centre.

The Crisis Line: 519 821 0140

Good2Talk: 1 866 925 5454

We would like to ask you to maintain confidentiality about the purpose of this experiment. Any previous knowledge pertaining to the purpose will bias the data for the other person and thus cannot be used.

For any complaints or questions about this research, or if you would like to know the results of this research once they are available, please feel free to contact Larissa Panetta.