Distribution Agreement

Eli B. Recht April 18, 2012

Chronotype and Facial Affect Processing: An Assessment Among the College Population

By

Eli B. Recht

Dr. Hillary Rodman
Adviser

Department of Psychology

Dr. Harold Gouzoules
Committee Member

Dr. Richard Williamon
Committee Member

2012

Chronotype and Facial Affect Processing: An Assessment Among the College Population

By

Eli B. Recht

Dr. Hillary Rodman
Adviser

An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Arts with Honors

Department of Psychology

2012

Abstract

Chronotype and Facial Affect Processing: An Assessment Among the College Population

By Eli B. Recht

Research suggests that a propensity towards evening activities correlates with a predisposition for mood disorders. Mood disorders, in turn, correlates with impaired social functioning. The purpose of this study was to investigate the impact of chronotype and temporal preference on social cognition, particularly facial affects processing. We recruited 69 undergraduate students (18 males, 51 females) for our sample. To determine chronotype, we placed subjects into an evening or non-evening group based on their scores from the Morningness-Eveningness Questionnaire (MEQ). To determine whether they were assessed at their preferred or non-preferred time of day, we placed subjects into a preferred or non-preferred group based on a match between their MEQ score and the time of their testing. Subjects were shown four facial expressions—anger, happiness, sadness, and surprise—each with ten equal gradients in increasing emotional intensity. During a computer judgment task, subjects rated these expressions using a 9-pt intensity scale. Our results show that there were no significant differences in the average intensity ratings of the four facial expressions between the evening group and the non-evening group or between the preferred-time group and the non-preferred-time group. However, we conducted an exploratory analysis, which demonstrated a time-of-day effect for college students to rate the intensity of facial expressions higher at the higher ranges of intensity during the evening than during the morning. Due to our small sample sizes and inconclusive results, future studies must be conducted to determine whether chronotype and time-of-day impact facial affect processing and social cognition. It is important that we continue investigating the relationships between chronotype, temporal preference, time of day, and social cognition, as significant findings may have large implications for treating mood and social cognitive disorders, especially in evening-oriented or highly social populations.

Keywords: circadian rhythm; chronotype; morningness; eveningness; mood; facial affect processing; social cognition; preference; time of day

Chronotype and Facial Affect Processing: An Assessment Among the College Population

By

Eli B. Recht

Dr. Hillary Rodman
Adviser

A thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Arts with Honors

Department of Psychology

2012

Acknowledgements

I would like to thank everybody who took part in my honors thesis and supported me in this most challenging endeavor. Firstly, I want to thank my family and friends for encouraging me to pursue this project and for supporting me always. Secondly, I want to thank Sonya Ali and Kyle Remy for their help around the lab, and Chelsie Cushman for assisting me in the preparation of my experiment. I want to thank Dr. Nancy Bliwise for taking the time from her busy schedule to assist me in statistical analyses and for providing me with the tools I needed to design my own experiment. I also want to thank Dr. Barbara Strock for her outstanding enthusiasm, guidance, and comic relief throughout this project. I cannot thank my committee members enough, Dr. Harold Gouzoules and Dr. Richard Williamon, for their support and encouragement throughout the year and for their inspiration both in and out of the classroom. Most importantly, I want to thank my advisor, Dr. Hillary Rodman, for her unwavering support, especially during busy times and stressful situations. Her enthusiasm in the classroom instilled passion within me my freshman year and inspired me to become a psychology major. Four years later, her guidance during my honors thesis has allowed me to actualize my potential and succeed beyond my own expectations. I am sincerely grateful for her wisdom and direction throughout my four years at Emory, as I would not be where I am today without her.

Table of Contents

Introduction 1
    Chronotype 1
    Facial Affect Processing 8
    The Present Study 11
Method 12
    Sample 12
    Materials and Measures 13
    Design 18
    Procedure 19
    Data Analytic Strategy 22
Results 23
    Chronotype 23
    Hypothesis 1 25
    Preference 27
    Hypothesis 2 27
    Emotion Recognition 29
Discussion 30
    Interpretation of Findings 30
    Contributions 36
    Implications 38
    Limitations and Future Directions 39
    Summary and Conclusions 41
References 42
Tables 46
Figures 53
Appendices 61

INTRODUCTION

It is well known that chronotypes, or individual circadian rhythms, influence some of our most fundamental biological rhythms, such as sleep and wakefulness. Their roles in certain aspects of our interpersonal lives, however, are less understood. Through associations with mood disorders and their symptoms, eveningness and social cognition may be related; we put this theory to the test by observing whether chronotype differences in facial affect processing exist. This study may be particularly relevant to the college environment—where students face an unusual abundance of social interactions, where students are more evening-oriented, and where mood disorders are on the rise.

In this paper, we begin with a literature review of chronotype and follow with one for facial affect processing. In the former, we outline a mechanism by which chronotype may be related to mood; in the latter, we describe one way in which mood can impact one's social cognitive functioning. Through these reviews, we provide rationale for why they may be linked. Lastly, we describe an experiment we conducted to explore their connection. By delving into this undiscovered relationship, we come closer to understanding the many factors that contribute to human cognition and that shape our lives.

Chronotype

Commonalities.

While the mathematical measurement of time may be a purely human construct, it nonetheless has come to exist within each of us: as our planet Earth completes a full daily rotation about its axis, we ourselves complete a full cycle of biological activities known as circadian rhythms. Derived from the Latin words *circa* meaning "around" and *diem* meaning "day", these roughly 24-hour internal rhythms are entrained by *zeitgebers*, or external cues from our environment; the most dominant is light (Roenneberg & Foster, 1997). Since this temporally consistent astronomical day has been recurring for the entirety of human history, we evolved to adapt to this light-dark cycle in physiological and behavioral ways, passing these adaptations on to our progeny for generations. As humans gradually evolved to depend on light for vision, we became diurnal species, with our active periods during sunlit hours and our resting periods during the dark (Moore, 1997).

This elaborate timing system is sustained by the suprachiasmatic nucleus (SCN) of the hypothalamus—our brains' internal pacemaker (Moore, 1997). The SCN has neural connections to and from certain locations in the brain responsible for a wide variety of biological functions. These functions include our daily rhythms of wakefulness, sleep, hormone secretion, body temperature (Martin, 2002), performance (Roenneberg, Wirz-Justice, & Merrow, 2003), endocrine regulation, metabolic activity, sensory integration (Moore, 1997), alertness, heart rate, and gene expression (Monteleone & Maj, 2008; Vandewalle, Maquet, & Dijk, 2009). By receiving light signals through the retina, the SCN synchronizes these biological functions to one another and to periods of environmental light.

While these endogenous systems are generally stable, circadian rhythms evolved in order to synchronize our activity patterns with those of our surroundings. Therefore, these rhythms must have the ability to adapt in a changing environment. Indeed, circadian rhythms show time shifts in rhythmicity in varying periods of light, such as during seasonal change (Martin, 2002), and in complete absence of light or darkness for extended periods of time (Moore, 1997). As a consequence of our circadian malleability, artificial light can gradually retrain our clocks and instantly increase cognitive functioning, such as attention, memory, and other executive brain processes (Vandewalle et al., 2009).

Light, however, is not the only *zeitgeber* capable of entraining our biological clocks. We live in complex environments, and so our circadian rhythms may show phase shifts as a result of a multitude of stimuli. Such non-photic *zeitgebers* include body temperature, attention, memory, sensory integration (Moore, 1997), locomotor activity and exercise (Moore, 1997; Mistlberger & Skene, 2005; Yamanaka, Hashimoto, Tanahashi, Nishide, Honma, & Honma, 2009), exogenous melatonin (Mistlberger & Skene, 2005; Moore, 1997), food intake (Stephan, 2002), drugs (Mrosovsky, 1988), stress (Bailey & Heitkemper, 2001; Moore, 1997), emotion (Moore, 1997), and social interaction (Aschoff, Fatranska, Giedke, Doerr, Stamm, & Wisser, 1971; Mrosovsky, 1988).

Individual Differences and Mood.

While the formal study of circadian rhythms began in 1728 (Martin, 2002), it was not until 1873 that scientists began to study *individual* circadian differences, coined as “chronotypes”. The first to do so was Theodor Jurgensen, a German doctor who categorized his patients into those with marked rhythms and those without. In 1900, American professor Michael O’Shea composed the first questionnaire designed to determine individual differences among these rhythms. Using this first questionnaire, later researchers began to discover that the general population could be divided into those who prefer to be active in the morning, coined as “larks”, and those who prefer to be active in the evening, coined as “owls”. These realizations, coinciding with an increasing interest in sleep research in the 20th century, led scientists to propose that a daily rest-activity cycle was a result of individual preferences (Horne & Ostberg, 1977). Thus, chronotypes became most significantly defined by the times in the 24-hour day that people *prefer* to wake up, fall asleep, and be most and least active (Kerkhof, 1985).

Slowly throughout the 20th century, researchers continued to refine their definitions constituting specific chronotypes. The greatest advancement came in 1976, when Jim Horne and Olov Ostberg developed the Morningness-Eveningness Questionnaire (MEQ), designed to divide the population into three categories (Morning, Intermediate, and Evening) based on individual temporal preferences for certain activities in the 24-hour day—such as sleeping, waking, eating, exercising, and working (Horne & Ostberg, 1977). Now the most widely accepted method for determining individual chronotypes, the MEQ has been utilized to shed light on a number of other differences between larks and owls, specifically in the realms of physiology, personality, and mood.

Larks, compared to owls, not only *prefer* to be active earlier in the day, but also tend to have higher daytime core body temperatures, lower post-peak temperatures, earlier peak oral temperatures (Horne & Ostberg, 1977), earlier food intake (Ostberg, 1973), shorter than 24-hour cycles, less variable sleep patterns, less vulnerability to disrupted sleep and sleep deprivation (Martin, 2002; Selvi, Gulec, Agargun, & Besiroglu, 2007), higher cortisol levels (Bailey & Heitkemper, 2001), earlier peak blood pressure levels (Uusitalo, Ahonen, Gorski, Tuomisto, & Turjanmaa, 1988), greater overall adrenaline secretion, and earlier times of peak alertness (Akerstedt & Froberg, 1976). Larks also have more autonomous circadian rhythms and so have more difficulty than owls adapting to situations involving a shift in the light-dark cycle (Horne & Ostberg, 1976)—such as jetlag, daylight savings time, or shift work (Selvi et al., 2007). Additionally, women and the elderly show trends toward morningness, while men and adolescents show trends toward eveningness (Chelminski, Ferarro, Petros, & Plaud, 1997;

Levandovski et al., 2011; Martin, 2002; Paradee, Rapport, Lumley, Hanks, Langenecker, & Whitman, 2008; Tsaousis, 2010).

Ioannis Tsaousis (2010) conducted a meta-analysis of 1,373 studies investigating the big five personality dimension differences among larks and owls. The findings showed that morningness moderately correlated with conscientiousness ($r = .36$), and to a lesser extent, with agreeableness ($r = .13$) and openness to experience ($r = -.09$). Morning types also tend to show increased cooperation, empathy, reliability, motivation, and effort to achieve a goal. On the other hand, evening types tend to show increased indecision, procrastination, impulsivity, and risk-taking behavior (Selvi, Gulec, Agargun, & Besiroglu, 2011; Tsaousis, 2010). The results comparing larks and owls to extraversion-introversion and to neuroticism-emotional stability are inconclusive.

Larks and owls also show contrasts in mood, independent of age or gender (Chelminski, Ferarro, Petros, & Plaud, 1999; Levandovski et al., 2011; Hidalgo et al., 2009). Owls are more likely to demonstrate pessimism (Hidalgo et al., 2009), bipolar disorder (Giglio, Magalhaes, Andersen, Walz, Jakobson, & Kapczinski, 2009), seasonal affective disorder (SAD) (Levandovski et al., 2011), and more violent suicide attempts (Selvi et al., 2011). Owls also show more symptoms of major depression (Drennan, Klauber, Kripje, & Goyette, 1991; Kitamura et al., 2010; Levandovski et al., 2011), regardless of whether participants are healthy or clinically depressed (Chelminski et al., 1999; Hidalgo et al., 2009). As preference for eveningness increases, the illness tends to be more severe, and vice versa (Kitamura et al., 2010). Moreover, there is no known association between depression and morning or intermediate types (Hidalgo et al., 2009; Kitamura et al., 2010).

Why do these differences between larks and owls exist? While the reasons remain unclear, it is speculated that differences in physiology, personality, and mood appear when our rhythms are inconsistent from day-to-day or misaligned with sunlit periods—both of which can occur with eveningness. In this way, a shift towards eveningness or an innate tendency to be evening-oriented can lead to a neurobiological dysfunction of the SCN; since the SCN is anatomically connected to limbic areas involved in emotional operations, this dysfunction may lead to mood disorders (Monteleone & Maj, 2008). Since humans evolved as diurnal species with a pacemaker that responds primarily to light, it is unsurprising that morningness is related to more positive characteristics and general health, while eveningness is related to more negative characteristics and psychiatric illness.

Altogether, researchers consider eveningness as not simply a characteristic of depressed patients, but rather as a biological and genetic predisposition, or vulnerability, for depression (Chelminski et al., 1999; Hidalgo et al., 2009; Kitamura et al., 2010; Monteleone & Maj, 2008); at the genetic and molecular level, a direct link between circadian disruption and depression is slowly emerging (Monteleone & Maj, 2008). Yet, since no study has proven a causal relationship between them, eveningness and depression may be linked through other factors. What, then, is mediating this relationship? Owls and people with mood disorders share commonalities in relation to sleep, light, and sociality.

Similarities between owls and depressed patients include sleep debt, shortened sleep duration, (Kitamura et al., 2010), abnormal REM sleep (Chelminski et al., 1999; Monteleone & Maj, 2008), shifted rhythms (Giglio et al., 2009), more variable sleeping patterns, elevated evening body temperatures, and later melatonin secretion (Monteleone & Maj, 2008); in fact, as the severity of these sleep abnormalities increases, so does the depression (Monteleone & Maj, 2008). Moreover, strict sleep regimens may be temporarily effective treatments for some patients with depression (Levandovski et al., 2011; Monteleone & Maj, 2008).

Owls and depressed patients also share similar phase shift responses to light and experience inadequate exposure to light (Levandovski et al., 2011; Hidalgo et al., 2009). Light can positively impact one's emotional and cognitive state and be effectively used as a treatment against depression and seasonal affective disorder (SAD) (Levandovski et al., 2011; Monteleone & Maj, 2008; Vandewalle et al., 2009). Genetically, owls and SAD patients, in contrast to healthy controls, possess the same difference in the NPAS2 gene family, which is involved in generating circadian rhythms (Hidalgo et al., 2009).

Social time may also mediate eveningness and depression. Social cues are capable of retraining our biological clocks in the absence of light (Aschoff et al., 1971; Chelminski et al., 1999; Levandovski et al., 2011; Mrosovsky, 1988). In agreement with this notion, individuals in highly social settings, such as urban cities and college campuses, are more likely to show tendencies towards eveningness and depression than people living in rural areas (Chelminski et al., 1997; Tsaousis, 2010); this suggests that evening social interactions may be causing depression by delaying one's biological clock, reducing one's time exposed to sunlight, or creating a chronic misalignment between one's sleep and work schedules. Additionally, evening social interaction also correlates with increased habits of smoking and drinking, both of which are known to inflict depressive mood states (Chelminski et al., 1997).

On the other hand, lack of strong social networks and/or ineptitude in social situations can cause depression, and vice versa (Beck, Rush, Shaw, & Emery, 1979; Levandovski et al., 2011). The evening, in comparison to the morning, gives socially vulnerable and depressed people an opportunity to remove themselves from, or immerse themselves in, high-pressured social situations. This tendency for the evening to be wrought with social isolation or anxiety, however, can exacerbate one's social vulnerability and one's depression, thus continuing the vicious cycle and strengthening the relationship between eveningness and depression.

In contrast to what researchers initially suspected, they now realize that individual chronotypes are influenced less by preference and more by incontrollable genetic and environmental factors. Yet, we can still shift our clocks by sheer will. Although this flexibility may be beneficial in some situations, it is not without its detriments: a tendency towards eveningness may lead to negative outcomes in one's physiology, personality, and mood (Monteleone & Maj, 2008).

Facial Affect Processing

Commonalities.

In 1872, Charles Darwin enlightened the scientific community to his observations that facial expressions are evolutionarily deeply rooted, follow the rules of natural selection, can be traced back to our common ancestors, and are universal in humans (Darwin, 1896); over 100 years later, the universality of facial expressions was confirmed (Ekman et al., 1987). These expressions would not have survived for so long or become so prevalent had they been unimportant. Facial expressions are one of the most salient social cues within human interactions. They help bestow upon each of us our identities and convey our internal emotional states to ourselves and to others. Thus, facial affect processing—the mechanisms by which we detect and interpret facial expressions—is critical for social adeptness.

Recent neuroscience has begun to uncover the neural and cognitive tasks our brains undergo during facial affect processing (it is important to note that the neural processes described here are in reality much more complex and much less localized to certain brain areas). Specific face cells, located in the fusiform face area (FFA) and the orbitofrontal cortex (OFC) are able to identify a perceived object as a face (Hadj-Bouziane, Bell, Knusten, Ungerleider, & Tootell, 2008; Rolls, Critchley, Browning, & Inoue, 2006). These face cells, along with specific hippocampal and amygdalaic neurons, can determine whether a perceived face is familiar or not (Tovee, 1996). Meanwhile, the superior temporal sulcus (STS) helps respond to biological motion—such as the direction and movement of the eye gaze, head, and mouth—to understand the intention of the person being perceived (Emery, 2000; Tovee, 1996). Upon further processing, the amygdala codes the face's specific expression and valence, and along with the prefrontal cortices and insula, aids in one's personal judgment of the emotions associated with it (Kuraoka & Nakamura, 2006; Sugase, Yamane, Ueno, & Kawano, 1999; Tovee, 1996). Altogether, there exists an interwoven and highly complex neural network dedicated mainly to face processing (Tovee, 1996).

Individual Differences and Mood.

Those who do not adequately process facial expressions may experience a level of social ineptitude. While virtually all human beings utilize the same neural network when processing facial expressions, people with disruptions in sleep, attention, and mood (to name just a relevant few) perceive differences in facial expressions relative to their counterparts. Sleep deprived patients show impaired ability to perceive the intensity of emotional expressions at the lower levels of expressive intensity; this coincides with the fact that sleep deprived patients display hypoactive prefrontal cortices involved in affective evaluation (Van der Helm, Gujar, & Walker, 2010). Paradee et al. (2008) found (in an elderly population) that people performed better at emotion recognition tasks when subjects were tested at their preferred times of activity, compared to their non-preferred times of activity, respective of their individual chronotypes; the closer one's time of testing is to one's preferential time of activity, the more accurately one performs.

Depressed patients also show differences in facial affect processing when compared to healthy populations. They tend to perceive expressions as sadder or less happy, they are more attentive to sad expressions than happy expressions, and they are less able to recognize every common emotion—especially sad and happy facial expressions (Bourke, Douglas, & Porter, 2010). Research also indicates that depressed patients demonstrate impaired discrimination for facial expressions displayed for short durations, and exhibit deficits when rating expressions of milder intensities; severity of depressive illness correlates with each of these impairments (Cavanagh & Geisler, 2006; Csukly, Czobor, Erika, Barnabas, & Lajos, 2009; Surguladze, Young, Senior, Brebion, Travis, & Philips, 2004).

In agreement with these cognitive data, depressed patients show abnormal FFA activation (Bourke et al., 2010), abnormal amygdala activation (Adolphs, 2008; Fales et al., 2008), reduced hippocampal volume (Sheline, Mittler, & Mintun, 2002), reduced insular activity (Liu et al., 2010), and deficits in prefrontal cortices (Fales et al., 2008) when rating emotional stimuli. Furthermore, depressed patients show deficits in other brain regions responsible for negativity bias, attention, and emotional processing (Fales et al., 2008).

Together, this research may indicate a level of social ineptitude in people who are sleep deprived or in people who are not functioning at their preferred times of activity. Furthermore, these data may explain why depressed patients have trouble interacting in social situations (Montagne et al., 2005).

The Present Study

We conducted an experiment investigating the relationship between chronotype and facial affect processing in order to determine whether eveningness is related to social cognition.

The review of individual chronotype differences reveals the possibility that eveningness may be a premorbid trait for depression. There are two reasons for this notion. First, a tendency towards eveningness may lead to SCN dysfunction, which in turn, may lead to mood disorders. Second, eveningness is associated with the presence of both mood disorders and factors related to mood disorders—such as abnormalities in physiology and sleep, similar light exposure, negative personality traits, and evening social interactions.

These two reviews together reveal the manner in which eveningness may be related to social cognition. People who exhibit sleep deprivation, depression, and functioning at non-preferred times of day all show similar deficits in facial affect processing—namely, blunted perception of emotional intensity at lower levels of expressiveness, and decreased emotion recognition accuracy. Since evening types often experience sleep deprivation, social interaction at non-preferred times of day (such as during morning hours), and depression, it is possible that they might display these same facial affect processing deficits. If such a relationship is found, it would reveal social cognition to be another avenue through which eveningness and depression are related. More importantly, it would indicate that, in addition to depression, eveningness may also be a risk factor for social ineptitude. It is possible, however, for the converse to be true: pre-existing social ineptness may in fact be the cause of one's eveningness and depression.

Although the facial affect processing studies mentioned above detected both directional causality and the existence of processing deficits, the present study does not, as it follows a simple cross-sectional descriptive design. Rather, we simply set out to investigate if there was a difference between chronotypes in their ratings of emotional intensity.

Findings from the previously mentioned studies enabled us to make two predictions:

1. Evening types will perceive facial expressions with less emotional intensity than morning or intermediate types, particularly at the low intensity range of expressiveness.

2. Participants tested at their preferred times of activity will perceive facial expressions with more emotional intensity than participants tested at their non-preferred times of activity, particularly at the low intensity range of expressiveness.

METHOD

Sample

Our sample consisted of 69 students (18 males and 51 females) attending Emory University in Atlanta, Georgia. Subjects ranged from 18-24 years old, with a mean age of 19.54 and a standard deviation of 1.34. The majority of participants identified themselves as Caucasian (52.2%), followed by East Asian (23.2%), African American (10.1%), South Asian (7.2%), Hispanic (2.9%), and of mixed descent (4.3%). Of the 69 participants, 34 were freshmen, 10 were sophomores, 14 were juniors, 9 were seniors, and 2 were graduate students. Thirty-four participants indicated that they were majoring in the social sciences, 12 in the natural sciences, 8 in the arts and humanities, and 15 remained undecided. We excluded participants if they did not have normal or corrected-to-normal vision and if they were above or below the range of 18-25 years of age. Volunteers participated in the experiment for either $10 (27 subjects) or for Introduction to Psychology course credit (42 subjects).

Materials and Measures

Morningness-Eveningness Questionnaire (MEQ).

The Morningness-Eveningness Questionnaire (MEQ) (Horne & Ostberg, 1976) is an extensively used self-report construct to determine a person's individual chronotype (Appendix A). Consisting of 19 questions, each with four to six answers to choose from, the MEQ asks about personal sleep-wake habits and temporal preferences for certain daily performances, such as eating, exercising, working, and alertness. Raw number scores range from 16 to 86, with lower scores indicating greater eveningness and higher scores indicating greater morningness. These raw scores also place participants into one of five categories: Definite Evening (16-30), Moderate Evening (31-41), Intermediate (42-58), Moderate Morning (59-69), and Definite Morning (70-86). We chose to use the MEQ because it is the most reliable and valid measure of chronotype to date. Test-retest reliability across two months was reported at .89, and the coefficient alpha for the scale generally ranges from .82 to .86 (Horne & Ostberg, 1976; Paradee, et al., 2008). The inter-item correlations generally range from -0.02 to +0.61, with a mean of 0.20, and the item-total correlations are also positively moderate. Validatory evidence comes from the fact that MEQ scores show strong predictive relationships with physiological, behavioral, and cognitive measures (Chelminski et al., 1997).

Three Factor Eating Questionnaire-R18 (TFEQ-R18).

We took measures to forestall hypothesis guessing by advertising the objective of our study as the desire to understand how college adjustment affects facial processing. In order to disguise our true objective, we included two other surveys similar in length and style to the

MEQ. The first of these was the TFEQ-R18 (Stunkard & Messick, 1985), which measures three different aspects of eating behavior: uncontrolled eating, cognitive restraint, and emotional eating (Appendix B). Originally developed in France as a 51-item construct, this revised 18-item self-report questionnaire asks participants to choose an answer to each question in a 4-point Likert-scale format, ranging from “Definitely False” (1) to “Definitely True” (4) for most of the questions. Raw scores are transformed to a 0-100 scale, in which higher scores indicate more uncontrolled eating, greater cognitive restraint, and more emotional eating.

Student Adaptation to College Questionnaire (SACQ).

The second of two surveys we used to disguise our study’s true intent was the SACQ (Baker & Siryk, 1989), designed to measure undergraduate students’ effectiveness in adjusting to college (Appendix C). In order to make this questionnaire equal in length to the MEQ, we selected 19 of 67 original questions. The inclusion criteria for these 19 questions were the words “college”, “adjustment”, or “academic”, or the concepts of mood, sleep, procrastination, or sociality (which are associated with chronotype). Participants were asked to answer each question in a 5-point Likert-scale format, ranging from “Applies Very Closely to Me” (1) to “Doesn’t Apply to Me At All” (5).

Stanford Sleepiness Scale (SSS).

In order to account for the possibility that differences in sleepiness on the day of testing may have been a confound, we administered the Stanford Sleepiness Scale (SSS) (Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973) to participants twice throughout the study (Appendix D). The SSS is a self-report scale consisting of 7 steps in increasing sleepiness, ranging from “Feeling active, vital, alert, or wide awake” (1) to “No longer fighting sleep, sleep onset soon; having dream-like thoughts” (7). Ideally, participants score a “1” during the time when they should be feeling most active, respective of their chronotype; scoring below a “3” during times of expected alertness indicates serious sleep debt. We chose to use the SSS, not only because it is quick, but also because previous sleep (Mograss et al., 2010; Van der Helm et al., 2010) and chronotype (Paradee et al., 2008) studies have found it useful. The SSS shows validity through correlations with performances on mental tasks, such as the Wilkinson Addition and Vigilance Tests ($r = .68$) and a brief memory test ($r = .47$). Additionally, SSS scores increase with increasing sleep debt (Hoddes et al., 1973).

Personal History Questions.

At the end of our study, participants answered 11 questions regarding personal variables known to impact chronotype and facial affect processing, such as native language, stimulant and depressant use, general sleep and wake times, and genetic history of sleep issues, psychiatric illness, or drug abuse (Appendix E). While each question was generated by the researchers themselves using guidelines from SurveyMonkey’s “Smart Survey Design” (SurveyMonkey, 2011), questions were influenced by previous sleep (Mograss et al., 2010; Van der Helm et al., 2010), chronotype (Horne & Ostberg, 1976; Selvi et al., 2007), and facial affect processing studies (Persad & Polivy, 1993; Van der Helm et al., 2010) asking similar questions.

NimStim Face Stimulus Set (NimStim).

To assess facial affect processing, NimStim faces (Tottenham et al., 2009) were used. Ten photographs from this stimulus set were chosen to represent the minimum and maximum intensities of the facial expressions presented to participants. These ten photographs depicted two Caucasian models, one male and one female, displaying five emotions each—Neutral, Happiness, Sadness, Anger, and Surprise—which are universally recognized (Ekman et al., 1987). Although there is no validity or reliability data for this stimulus set yet, preliminary findings indicate high expression recognition among adults and children, and high intra-participant agreement across two testing sessions (Tottenham et al., 2009). We chose NimStim for a number of reasons: it is currently the most extensive facial expression database (with 646 stimuli and 43 models to choose from), its models activated the correct facial muscles for each expression (Tottenham et al., 2009), its models are young university adults (maintaining ecological relevance for a college assessment), and each face is represented in frontal view taken from the same distance under the same background and light conditions. Additionally, NimStim has proven adequate in previous chronotype and facial affect processing studies (Palermo & Coltheart, 2004; Paradee et al., 2008).

We chose our two models based on a number of exclusion criteria. Evidence shows that people innately rate other-race faces differently than same-race faces, regardless of the other-race of the model being judged (Matsumoto, 1993); more recent evidence suggests that these other-race effects may be reversed or deemed insignificant with exposure to other-race faces during childhood (Sangrigoli, Pallier, Argenti, Ventureyra, & Schonen, 2005). Due to the likelihood that the majority of our subjects would be Caucasian and that most of our non-Caucasian subjects would be familiar with Caucasian faces since childhood, we used only Caucasian models to reduce variability in participants' intensity ratings. Of the Caucasian choices in the NimStim set, we excluded models if they were among the members of the set whose images the authors deemed publishable (decreasing the chances that participants had seen them before), had prominent hair covering their faces (including facial hair), or if their expressions were intimidating or menacing (as determined by pilot observations). Of the remaining models, we chose the one male model (87.5% recognition accuracy) and the one female model (89.3% recognition accuracy) with the highest average recognition accuracy of their five expressions (as rated by 70 adults from preliminary ratings conducted by the authors of NimStim); comparing the recognition accuracy differences for each expression between the two models yields a mean difference of 0.03% with a standard deviation of 0.05; each expression was recognized with similar accuracy in both models. In order to create realistic photographs in the morphing process (see next), only expressions without teeth were used.

Abrosoft Fantamorph Version 5.

To obtain varying intensities of expressiveness for each facial expression, we used *Abrosoft Fantamorph Version 5* (www.fantamorph.com), which received multiple awards for being the best morphing software of 2011. We selected the morphing strategy to probe facial affect intensity processing because morphing produces facial expressions equal in their intensity differences from one gradient to the next, allowing for more systematic ratings and a more accurate understanding of where on the intensity spectrum participants differ in their subjective ratings. In addition, previous studies investigating the effects of depression (Cavanagh & Geisler, 2006; Csukly et al., 2009), sleep deprivation (Van der Helm et al., 2010), and ethnic differences (Walker & Tanaka, 2003) have found it a robust strategy for studying facial affect intensity recognition.

In order to reduce distraction from the most salient facial features and to prevent biases towards the models (either by recognizing them from previous studies or by comparing them to similar-looking people), we converted the ten NimStim photographs to gray-scale for equal inter-photo pigmentation and cropped external features (hair, ears, and jaw line) (Sinha, Balas, Ostrovsky, & Russel, 2006). Neutral faces were then paired with each of the other four expressions by the same model—Happiness, Sadness, Anger, and Surprise. Fantamorph averaged the facial features between the photograph pairs on a continuum and kept them constant by key points on both pictures (16 points for the outline of the face, 4 points for the forehead, 11 points for each eyebrow, 21 points for each eye, 5 points for each cheek, 19 points for the nose, 22 points for the mouth, and 3 points for the chin). Fantamorph then applied a warping algorithm to create 10 equal steps of progressive intensity from the neutral face to each expressive face. This resulted in 20 images for each expression, 40 images for each model, and 80 images in total.

Stimulus Presentation.

Neurobehavioral Systems Inc. Presentation Version 14.9 (www.neurobs.com) was used to deliver the stimuli to the participants. It delivered the stimuli in organized groups, in random generation, and it recorded the data produced by the participants. Each photograph was scaled to the dimensions of 5.33 x 7.97 inches, or 512 x 765 pixels, in order to approximate the size of a real human face (for ecological relevance) and to obtain clear resolution (Sinha et al., 2006). Photographs were presented in the center of a 20 x 12 inch desktop computer screen with a black background at roughly 25 inches away from the participant.

Design

The current descriptive study follows a cross-sectional design.

We controlled for a number of confounds associated with differences in chronotype and facial affect processing. We restricted the participants' age range to 18-25 years old because research shows that as one's age increases, one tends to be more morning-oriented (Chelminski et al., 1999; Levandovski et al., 2011; Paradee et al., 2008; Tsaousis, 2010), less able to process faces (Paradee et al., 2008), and more depressed (Hidalgo et al., 2009). Additionally, the same time of the day may mean different things for different cohorts (Horne & Ostberg, 1976); by testing only participants of a young adult cohort, we were able to reduce the variability caused by age. We also excluded participants without normal or corrected-to-normal vision at the time of testing, since adequate vision is crucial when rating subtle changes in emotional intensity. To control for other-race effects, we selected only Caucasian models for our face stimuli. To control for cognitive changes induced by both artificial and natural light (Vandewalle et al., 2009), we kept the amount of artificial light in the laboratory constant and blocked out any sunlight with blackout material.

Procedure

The study protocol was approved by the Emory University Institutional Review Board (IRB) Human Subjects Committee. All participants signed an informed Consent Form before the initiation of the assessment.

In order for us to acquire data from morning types and evening types during their preferred and non-preferred times of activity, subjects participated in our study during one of six time slots: 7:00 AM, 8:00 AM, 9:00 AM, 7:00 PM, 8:00 PM, or 9:00 PM. These times coincide with the peak times of alertness for the general and college populations, and with the peak and dull times of alertness for larks and owls during "typical" waking hours (Dement & Vaughan, 1999; Lavie, 1996). More specifically, 8:00 AM is when the general population, the college population, and larks show peak wakeful alertness, and when owls show their lowest point of wakeful alertness. Comparatively, 8:00 PM is when the general population, the college population, and owls show peak wakeful alertness, and when larks show their lowest point of wakeful alertness; for each of these populations, an inverted-U curve forms around these peak times. Additionally, there is a significant point of low wakeful alertness shared by the entire population during the mid-to-late evening (Dement & Vaughan, 1999; Lavie, 1996). Because students' sleep schedules vary considerably during the weekends (Roenneberg et al., 2003), we only offered times during the weekdays.

First, the experimenter administered the first survey packet containing a brief demographic survey (Appendix F), the TFEQ-R18 (Appendix B), the MEQ (Appendix A), the selected SACQ questions (Appendix C), and the SSS (Appendix D) in that order. Participants then underwent a familiarization phase in front of a desktop computer screen to acquaint themselves with the range of emotional intensity of the stimuli they would later be rating. The familiarization phase randomly presented the intensities of 10%, 40%, 70%, and 100% (out of ten equal gradients) for each emotion—Happiness, Sadness, Anger, and Surprise—depicted by each model. The participants simply pressed the Spacebar after viewing each of these 32 photographs in order to move on to the next example.

After a one-minute break, the participants began the real assessment. Every subject was presented with four groups of photographs, one at a time, each depicting one of the four emotions. These four groups were presented in the same order to every participant: Anger first, Happiness second, Sadness third, and Surprise fourth. Subjects were not told which emotions they would be viewing. Within each group, 20 photographs (10 gradients in intensity for both models) were randomly generated twice for a total of 40 stimuli per group. Participants were instructed to take as much time as needed when rating each photograph. They used a 9-point Likert-scale format on the keyboard, ranging from the lowest intensity of expressiveness (1) to the highest intensity of expressiveness (9).

The participants were given as much time as needed when rating each stimulus for two reasons: to investigate facial affect processing at full capacity when detecting subtle changes in intensity and to reduce the difference between people rating different races (Elfenbein & Nalini, 2003) or the same gender (Hoffman et al., 2006) as their own. We also used the 9-point scale for two reasons: it looks visually continuous across the top of the keyboard and so reduces the cognitive effort required to match a subjective judgment to an objective number, and facial affect processing studies have found the 9-point scale robust (Ekman et al., 1987; Matsumoto, 1993) due to its high accuracy (Treiblmeier & Filzmoser, 2009).

Once each photograph was rated, the computer screen turned black for 1000 milliseconds before the next stimulus appeared. After each group was completed, the participant was asked to hand-write the name of the emotion he/she believed was just presented among the 40 photographs in the group (Appendix G). In total, each participant generated 160 ratings and wrote down 4 emotions.

After each participant completed the computer judgment task, the experimenter administered the second survey packet containing the SSS again and the personal history questions (Appendix E). Finally, the subjects were fully debriefed according to IRB protocol, asked not to discuss the study with other subjects, thanked for their participation, and compensated with either $10 or course credit, dependent upon the method by which they were recruited.

The study, in total, required approximately 45 minutes for completion.

Reducing Threats to Validity.

We took measures to reduce some potential threats to validity; these are reflected in our study design. First, by advertising a false study objective to participants and by using two surveys in addition to the MEQ to support this deception, we attempted to forestall hypothesis guessing. Second, since both the experimenter and the participant did not know the participant's chronotype at the time of testing, this double-blind design reduced experimenter expectancy effects. Additionally, subject-expectancy effects, evaluation apprehension, and measurement reactivity were all reduced because the experimenter sat in a separate room of the laboratory when participants were performing each task. Lastly, to maintain consistency and to reduce instrumentation effects, the same male experimenter conducted all 69 assessments in the same laboratory using the same memorized procedure script; every participant used the exact same chair, table, pen, and computer.

Data Analytic Strategy

We reduced each participant's 160 response data points from the computer judgment task to 80 data points by averaging the ratings of Trial 1 and Trial 2 of the same stimulus. Mean test-retest reliability for all stimuli across the 69 participants was 0.64 with a standard deviation of 0.12, indicating strong overall positive correlations between the two trial ratings of the same stimuli. A sliding window approach was then utilized, which averaged the rating scores of adjacent intensity levels for the 10 gradients. For example, intensity levels 1 and 2 were averaged to make data point 1-2, intensity levels 2 and 3 were averaged to make data point 2-3, and so on until data point 9-10. This smoothing technique reduced noise caused by participant rating variability and resulted in 9 data points for each subject (Van der Helm et al., 2010).

For each of our hypotheses, Repeated Measures Analyses of Variance (ANOVA) were conducted—the within-subjects variable being stimulus intensity (9 steps) and the between-subjects variables being chronotype (2 groups) or preference (2 groups). Assumptions of Normality were confirmed for all analyses conducted. When the assumption of Homogeneity (Levene's Tests for Equality of Error Variances) was violated, either an Independent-Samples T-test or a non-parametric Independent-Samples Kruskal-Wallis H Test was utilized. For the majority of ANOVA, the assumption of Sphericity (Mauchly's Test of Sphericity) was violated; in these cases, the Greenhouse-Geisser Test, a conservative adjustment towards sphericity, was used. The assumption of Equality of Covariances (Box's M Test) was either confirmed for the

ANOVA or rendered irrelevant by equal group sizes. For all analyses, statistical significance was set at $p < .05$ (two-tailed) and trends were discussed at $p < .08$ (two-tailed).

All statistical analyses were performed using the IBM SPSS Program Version 19.0.

RESULTS

In order to better understand the results of our hypotheses, we will speak first about our chronotype results. Then we will discuss the hypotheses, and lastly, emotion recognition.

Chronotype

The frequency distribution of MEQ scores among the 69 students closely approximates a curve of normal distribution with a skewness = -.23 and a kurtosis = -.12 (Figure 1). Table 1 provides descriptive statistics for the MEQ score among participants. Figure 2 shows that out of 69 participants, 0 were the definite morning type, 2 were the moderate morning type (2.9%), 43 were the intermediate type (62.3%), 20 were the moderate evening type (29.0%), and 4 were the definite evening type (5.8%). Combining definite morning and moderate morning into “Morning type” and combining definite evening and moderate evening into “Evening type” gives us 2 morning types (2.9%), 43 intermediate types (62.3%), and 24 evening types (34.8%).

Out of 18 males, none were morning types, 10 were intermediate types (55.6%), and 8 were evening types (44.4%); Out of 51 females, 2 were morning types (4.0%), 33 were intermediate types (64.7%), and 16 were evening types (31.4%). With an independent-samples t-test, we found no significant difference between male ($M = 42.8$, $SD = 8.46$) and female ($M = 44.5$, $SD = 8.61$) MEQ scores; $t(67) = -0.69$, $p = 0.49$. There was also no difference in the distribution of males and females into the MEQ categories, $X^2(3, N = 69) = 1.71$, $p = .634$.

We found a high correlation between participants' placement of themselves into a chronotype category using a single question from the MEQ itself (Appendix A, #19) and their overall MEQ scores (r = -.75), indicating that participants have a very good idea of where on the chronotype spectrum they fall. We also found a high correlation between general time of sleep onset (Appendix E, #9) and MEQ score (r = .47), indicating that eveningness increases the later the sleep onset time. Additionally, we found significant negative correlations with participants' MEQ categories and two questions on the SACQ (Appendix C, # 9 and # 14); as morningness increases, effort in school (r = -.25) and efficiency of study time (r = -.30) both increase.

MEQ scores did not correlate with mood (Appendix C, #8), sleep deprivation (average ratings of both SSS scores, Appendix D), or the sociality questions from the SACQ (Appendix C, #17 and #19). However, mood did significantly correlate with the sociality questions from the SACQ; namely, as one's negative mood increases, the feeling of having enough social skills to get along well in the college setting decreases (r = -.30), and difficulty feeling at ease with other people in college increases (r = .32).

Since our sample included very few morning types, we devised an alternative strategy to examine the extremes of our distribution. By splitting the data into two groups of 24 participants each (34.8% each)—with the "evening" group consisting of the 24 evening types and the "non-evening" group consisting of the 24 participants closest to the morning side of the chronotype spectrum—we were able to differentiate the evening types from their counterparts as much as possible while maintaining equal group sizes. This partition excluded the 21 intermediate-type participants (30.4%) that fell within the MEQ score range of 42-46 (Figure 3). It should be noted that this adjustment from morningness to non-eveningness does not contradict our hypothesis, as there is no known association between depression and intermediate types (Hidalgo et al., 2009;

Kitamura et al., 2010). Table 2 provides descriptive statistics of the participants in these two groups.

Hypothesis 1

To determine whether our first hypothesis was true—that evening types will rate the intensity of emotional expressions as less intense than morning or intermediate types, particularly at the low intensity range of expressiveness—we first combined data across all four emotions (to examine overall influence of chronotype on intensity ratings) and then analyzed each emotion separately. Table 3 summarizes these results (including overall mean score), and Figures 4, 5, 6, 7, and 8 individually depict the results for each of the five ANOVA.

Between-Subjects Main Effects. Evening-types and non-evening types did not significantly differ in their ratings of emotional intensity (main effect of chronotype on subjective intensity ratings for all emotions combined: $F(1, 46) = 0.31$, $p = .58$, $n_p^2 = .007$; for anger: $F(1, 46) = 0.30$, $p = .60$, $n_p^2 = .006$; for happiness: $F(1, 46) = 0.82$, $p = .37$, $n_p^2 = .018$; for sadness: $F(1, 46) = 0.008$, $p = .93$, $n_p^2 = .000$; for surprise: $F(1, 46) = 0.15$, $p = .70$, $n_p^2 = .003$).

Within-Subjects Main Effects. Increased stimulus intensity generated significantly increased subjective ratings of intensity for both groups (main effect of stimulus intensity on subjective ratings for all emotions combined: $F(1.20, 55.4) = 310.6$, $p < .001$, $n_p^2 = .87$; for anger: $F(1.74, 80.2) = 237.7$, $p < .001$, $n_p^2 = .84$; for happiness: $F(1.44, 66.2) = 157.5$, $p < .001$, $n_p^2 = .77$; for sadness: $F(1.30, 59.8) = 135.3$, $p < .001$, $n_p^2 = .75$; for surprise: $F(1.86, 85.7) = 405.4$, $p < .001$, $n_p^2 = .90$). Each has a large effect size.

Interactions. There were no significant interactions between chronotype and stimulus intensity (for all emotions combined: $F(1.20, 55.4) = 0.35$, $p = .60$, $n_p^2 = .007$; for anger: $F(1.74, 80.2) = 0.32$, $p = .70$, $n_p^2 = .007$; for happiness: $F(1.44, 66.2) = 1.18$, $p = .30$, $n_p^2 = .025$; for sadness: : $F(1.30, 59.8) = 0.31$, $p = .64$, $n_p^2 = .007$; for surprise: $F(1.86, 85.7) = 0.33$, $p = .71$, $n_p^2 = .007$).

Controlling for Influences to Hypothesis 1.

Since ethnicity (Ekman et al., 1987; Matsumoto, 1993), language of origin (Matsumoto & Assar, 1992), gender (Cellerino, Borghetti, & Sartucci, 2004; Hoffman et al., 2006; Montagne et al., 2005; Rehnman & Herlitz, 2006), level of sleep deprivation (Van der Helm et al., 2010), and mood (Bourke et al., 2010; Cavanagh & Geisler, 2006; Csukly et al., 2009; Surguladze et al., 2004) have been shown to influence facial affect processing, we ran analyses to determine if these variables were statistically associated with the results of hypothesis 1. We found no significant between-subjects interactions or 3-way interactions with participants' ethnicity (Appendix F, #5) or gender (Appendix F, #2). With a Repeated Measures Analysis of Covariance (ANCOVA), we found no significant between-subjects interactions or 3-way interactions with participants' level of sleep deprivation or mood. We did find significant between-subjects interactions with participants' language of origin (Appendix E, #3) for all emotions combined, $F(1, 44) = 4.13$, $p = .05$, $n_p^2 = .086$, for sad faces, $F(1, 44) = 4.13$, $p = .05$, $n_p^2 = .086$, and for surprised faces, $F(1, 44) = 7.87$, $p = .007$, $n_p^2 = .152$, but no 3-way interactions. To control for this, we ran analyses for the evening vs. non-evening groups excluding non-native English speakers (N=20 each). We still obtained no significant results for hypothesis 1.

Other Related Analyses.

To further inquire about hypothesis 1, we ran some related tests. With a Repeated Measures ANCOVA, we found no significant effects for individual MEQ scores and intensity ratings for all emotions combined or for each emotion separately. We also ran ANOVA based on measures that the MEQ was found to be correlated with, such as where on the chronotype spectrum participants believed they fell (Appendix A, #19)—eveningness consisting of 43 participants and morningness consisting of 26 participants— and when participants generally fell asleep (Appendix E, #9); we obtained no significant results for all emotions combined or for each emotion separately.

Preference

We operationalized Preference by MEQ category (Figure 2) and time of testing: evening types tested at night (14) and morning types tested in the morning (1) added up to 15 participants tested at their preferred time (21.7%). Evening types tested in the morning (10) and morning types tested at night (1) added up to 11 participants tested at their non-preferred time (15.9%). Table 4 provides descriptive statistics of participants in these two groups.

Hypothesis 2

To determine whether our second hypothesis was true—that participants tested at their preferred times of activity will rate the intensity of faces higher than participants tested at their non-preferred times of activity, particularly at the low intensity range of expressiveness—we again first combined data across all four emotions and then analyzed each emotion separately. Table 5 summarizes these results (including overall means), and Figures 9, 10, 11, 12, and 13 individually depict the results for each of the five ANOVA.

Between-Subjects Main Effects. Preferred time and non-preferred time subjects did not significantly differ in their ratings of emotional intensity (main effect of preference on subjective intensity ratings for all emotions combined: $F(1, 24) = 1.51$, $p = .23$, $n_p^2 = .06$; for anger: $F(1, 24) = 1.16$, $p = .29$, $n_p^2 = .05$; for happiness: $F(1, 24) = 1.29$, $p = .27$, $n_p^2 = .05$; for sadness: $F(1, 24) = 1.71$, $p = .20$, $n_p^2 = .07$; for surprise: $F(1, 24) = 0.55$, $p = .47$, $n_p^2 = .02$). We did, however, find a trend for the preferred time group to rate the angry faces at intensity point 9 higher than the non-preferred time group.

Within-Subjects Main Effects. Increased stimulus intensity generated significantly increased subjective ratings of intensity for both groups (main effect of stimulus intensity on subjective ratings for all emotions combined: $F(1.19, 28.6) = 165$, $p < .001$, $n_p^2 = .87$; for anger: $F(1.80, 43.1) = 127$, $p < .001$, $n_p^2 = .84$; for happiness: $F(1.51, 35.8) = 113$, $p < .001$, $n_p^2 = .83$; for sadness: $F(1.23, 29.6) = 58.3$, $p < .001$, $n_p^2 = .71$; for surprise: $F(1.85, 44.3) = 203$, $p < .001$, $n_p^2 = .89$). Each has a large effect size.

Interactions. There were no significant interactions between preference and stimulus intensity (for all emotions combined: $F(1.19, 28.6) = 0.91$, $p = .37$, $n_p^2 = .04$; for anger: $F(1.80, 43.1) = 0.52$, $p = .58$, $n_p^2 = .02$; for happiness: $F(1.51, 35.8) = 1.70$, $p = .20$, $n_p^2 = .07$; for sadness: : $F(1.23, 29.6) = 0.42$, $p = .57$, $n_p^2 = .02$; for surprise: $F(1.85, 44.3) = 1.42$, $p = .25$, $n_p^2 = .06$).

Controlling for Influences to Hypothesis 2.

For the five ANOVA of hypothesis 2, we found no significant between-subjects interactions or 3-way interactions with participants' ethnicity, language of origin, or gender. With a Repeated Measures ANCOVA, we found no significant between-subjects interactions or 3-way interactions with participants' level of sleep deprivation or mood.

Other Related Analyses.

To further inquire about the results of our hypotheses, we split all 69 participants into two groups based solely on time of testing. Group AM (N = 33) consisted of the participants that underwent the assessment in the morning (between 7:00 AM – 10:00 AM), while group PM (N = 36) consisted of the participants that underwent the assessment in the evening (between 7:00 PM

– 10:00 PM). Table 6 provides descriptive statistics of participants in these two groups. For all the emotions combined, we found a significant interaction, $F(1.24, 83.0) = 3.82$, $p = .045$, $n_p^2 = .054$, and a significant between-subjects main effect, $F(1, 67) = 4.31$, $p = .042$, $n_p^2 = .06$, particularly at intensity points 5 - 9 (Figure 14). For the angry faces, we found a significant between-subjects main effect, $F(1, 67) = 4.37$, $p = .04$, $n_p^2 = .06$, specifically at intensity points 8 and 9 along with trends at points 3 - 6 (Figure 15). For the sad faces, we found a significant interaction, $F(1.45, 97.13) = 5.21$, $p = .014$, $n_p^2 = .072$, and a significant between-subjects main effect, $F(1, 67) = 6.84$, $p = .011$, $n_p^2 = .093$, specifically at intensity points 5 - 9 (Figure 16). For each of these analyses, the AM group rated the faces as less expressive than did the PM group. We found no significant difference between these groups for the happy or surprised faces. Table 7 summarizes these results (including overall means).

Emotion Recognition

In addition to the stimulus ratings, participants also identified the four emotions by name (Appendix G). Out of the 69 total participants, 57 wrote “Angry”, “Mad”, or “Upset” for the Angry face-stimulus set (82.6%), 63 wrote “Happy” or “Joyous” for the Happy face-stimulus set (91.3%), 65 wrote “Sad” for the Sad face stimulus-set (94.2%), and 67 wrote “Surprised” or “Shocked” for the Surprised face-stimulus set (97.1%). The vast majority of participants (78.3%) correctly identified all four of the emotions they rated; only 14.5% identified one emotion incorrectly, 2.9% identified two emotions incorrectly, and 4.3% identified three emotions incorrectly. Using a chi-square analysis, we found that MEQ category, $X^2(9, N = 69) = 12.02$, $p = .212$, gender, $X^2(3, N = 69) = 0.87$, $p = .83$, ethnicity, $X^2(15, N = 69) = 10.5$, $p = .78$, level of sleep deprivation, $X^2(27, N = 69) = 25.1$, $p = .57$, mood, $X^2(4, N = 69) = 7.90$, $p = .095$, preference, $X^2(3, N = 26) = 1.51$, $p = .68$, time of testing, $X^2(3, N = 69) = 2.47$, $p = .48$, and language of origin, $X^2(3, N = 69) = 1.23$, $p = .75$, had no significant associations with whether participants correctly or incorrectly identified the emotions.

DISCUSSION

Interpretation of Findings

As in the results section, we will first interpret our chronotype findings in order to facilitate a better discussion of our hypotheses. Then, we will discuss emotion recognition.

Chronotype.

Together with previous research (Chelminski et al., 1997; Levandovski et al., 2011; Martin, 2002; Tsaousis, 2010), our results indicate that college students are evening-oriented. This is in contrast to the adult population, and certainly more so to the elderly population (Paradee et al., 2008). This discrepancy in chronotype as a function of age may be due to a combination of factors—specifically, the changing demands of one's lifestyle as age increases, the increased dependence on social and environmental synchronizers (which are mostly morning-oriented) as a result of reduced neuronal activity of the SCN with age (Chelminksi et al., 1999), or the different hormonal levels between adolescents and adults (Levandovski et al., 2011).

Inconsistent with previous research, our results indicate that college males and college females do not differ in chronotype; many studies have found females to be more morning-oriented than males, independent of age (Chelminski et al., 1997; Levandovski et al., 2011; Martin, 2002; Tsaousis, 2010). Our results, however, are unsurprising, as the literature demonstrates increasing chronotype gender differences with age, particularly after the age of 50 (Moore, 2002; Tsaousis, 2010); a possible reason for this may be that men and women face significantly different biological, professional, and social pressures in adulthood (Moore, 2002), but less so in adolescence.

In agreement with Tsaousis (2010), we found that as morningness increases, effort in school and efficiency of study time also increase. These characteristics both fall under the umbrella of conscientiousness—the big five personality dimension most strongly related to morningness (Tsaousis, 2010). Evening types may show less conscientiousness and academic motivation than do morning types due to environmental factors, such as agitated sleep schedules, less light exposure, or more evening sociality, which can result in the vicious cycle of academic motivation loss and negative changes in mood. Since personality is generally stable throughout one's life, these differences may also reflect genetic divergence among chronotypes.

More importantly, and somewhat at odds with our core hypothesis (see below), is the fact that we found no significant relationship between eveningness and mood (Appendix C, # 8) or eveningness and sleep deprivation (Appendix D). This is in stark contrast with previous literature (Chelminski et al., 1999; Levandovski et al., 2011; Hidalgo et al., 2009); it is probable that we obtained these results because our measures of mood and sleep deprivation are insufficient for adequately measuring them in a careful fashion. The fact that we did not find a significant relationship between eveningness and mood or eveningness and sociality (Appendix C, # 17 and # 19), but that we did find a significant relationship between mood and sociality, suggests at first glance that our core hypothesis—that eveningness and social cognition are related through their mutual association with mood—may be incorrect. It is possible that eveningness and mood are not directly related, but related through a host of other factors not present or controlled for in our college sample, such as sleep patterns, light exposure, or nighttime social interactions.

Hypothesis 1.

Our first hypothesis—that evening types would rate the intensity of facial expressions lower than morning or intermediate types, particularly at the low intensity range of emotion—was not supported (Table 3); we found no significant relationship between chronotype and emotional intensity perception. As described in the Introduction, previous research points to a tendency for evening types to display more depressive symptoms than morning and non-evening types (Chelminski et al., 1999; Drennan et al., 1991; Hidalgo et al., 2009; Kitamura et al., 2010; Levandovski et al., 2011) and for people with depressive symptoms to rate emotional expressions less intensely than healthy participants (Surguladze et al., 2004). We may have obtained these results due to a number of factors, such as the potential true relation of mood to chronotype, the age range of our subject pool, or the design of our study.

Despite the fact that eveningness may reflect pre-morbidity for a mood disorder (Chelminski et al., 1999; Hidalgo et al., 2009; Kitamura et al., 2010; Monteleone & Maj, 2008), our results suggest that the presence of eveningness alone, in the absence of depression being manifested, may be insufficient for the existence of depressive-like emotion deficits, such as affective blunting; this explanation is supported by the fact that eveningness was not significantly correlated with mood or sociality, but is unsupported in the fact that we found significant correlations between mood and sociality—indicating that mood was in fact present in our sample (so much so that it was found to be strongly correlated with social pressures). Once again, our results may support the notion that eveningness and depression are not directly related, but rather connected through a host of other factors not controlled for or present in our sample. It is also possible that in order for eveningness to cause depression, some environmental stressor must be paired with it. However, since we did not adequately measure the mood states or environments of our participants, these conclusions are difficult to support.

Adolescents and young adults have a lower probability of reporting depressive symptoms (Hidalgo et al., 2009) even though they are more evening-oriented (Chelminski et al., 1997; Levandovski et al., 2011; Paradee et al., 2008; Tsaousis, 2010). Chronotype, therefore, may only predict the onset of depression with increasing age. It is also possible that, if some of our subjects do have depressive tendencies, these symptoms may not be severe enough to alter the neurological pathways involved in the perception of emotions; college students may also be more resilient to the effects of depression than are adults or the elderly (a discussion of cognitive reserve follows hypothesis 2). While depressive college students are more likely to be evening types than morning types (Chelminski et al., 1999), it is unlikely that evening types are more likely to be depressed than healthy.

It is also possible that our computer judgment task was not difficult enough to discriminate between evening types with or without depressive symptoms, since depressed patients show impairments when processing faces shown for short durations and when rating faces of milder intensity (Surguladze et al., 2004). We also did not obtain enough morning types to adequately compare morningness with eveningness; thus, our evening and non-evening groups may not have been different enough in chronotype to detect a difference (Figure 3).

Hypothesis 2.

Our second hypothesis—that participants tested at their preferred times of activity would rate the intensity of facial expressions higher than participants tested at their non-preferred times of activity, particularly at the low intensity range of expressiveness—was also not supported (Table 5); we found no significant relationship between temporal preference and emotional intensity perception. We did, however, find a trend for preferred time types to perceive high intensity angry faces more intensely than non-preferred time types (Figure 10). The results from hypothesis 2 are for the most part inconsistent with previous research (first, because we found no significance, and second, because the trend we found was in the high intensity range of expressiveness rather than in the low intensity range) that demonstrated (in an elderly population) that people tested at their preferred times of day show more accurate facial affect processing (specifically, emotion recognition) than people tested at their non-preferred times of day (Paradee et al., 2008).

The results from both of our hypotheses may support the notion of cognitive reserve—the amount of mental compensation one can provide for an increasingly demanding task in the face of opposition (Paradee et al., 2008; Tucker & Stern, 2011). For example, preference and non-preference may not be as important of a distinction for college students—who are highly cognitively intact and very capable of mentally compensating for an increasingly difficult task—as it is for an elderly population, whose brains have begun to deteriorate; furthermore, this preference effect is even more pronounced in elderly patients with acquired brain injury, who have lost almost all of their cognitive resources upon which to call (Paradee et al., 2008; Tucker & Stern, 2011). In the same breath, even if our evening sample did in fact show depressive symptoms, we may not have been able to detect a difference between morning types and evening types in their ratings of emotional intensity because these evening types may have been able to overcome the difficulty of the task with a wealth of cognitive reserve.

Emotion Recognition.

Overall, the emotions were correctly identified (angry at 82.6%; happy at 91.3%; sad at 94.2%; surprise at 97.1%). Moreover, most of our participants correctly identified all four of the emotions they rated (78.3%). We found no significant relationship between emotion recognition accuracy and either chronotype or temporal preference, which is inconsistent with Paradee et al. (2008), who found in an elderly population that testing during preferred times of activity results in fewer errors when recognizing emotions. More importantly, these results are again inconsistent with our core hypothesis that chronotype and social cognition are significantly related; this notion is further supported by the fact that we found no significant relationship between emotion recognition and mood or sleep deprivation, both of which are highly associated with eveningness.

Exploratory Analyses.

The results of our exploratory analyses—which demonstrate that college students may generally perceive faces of anger (Figure 15) and sadness (Figure 16) more intensely in the evening than in the morning, particularly at higher intensities— indicate the possibility that our nonsignificant results from hypothesis 2 are due to insufficient power. This possibility is apparent when we compare the temporal preference graphs to the time of testing graphs, as the visual trends are similar. The majority of our subjects were tested at night (52.2%) and our sample was slightly evening-oriented; this suggests overall that our subjects preferred the evening over the morning test time. Thus, social cognition and chronotype may in fact be related but in the opposite direction of our predictions: college students may show deficits in social cognition during the morning rather than during the evening; college students are more sensitive to highly expressive emotions during their preferred time of day (the evening) than during their non-preferred time of day despite the relationship between eveningness and mood or mood and social ineptitude.

Upon summarizing studies investigating chronotype and temporal preference on cognitive functioning, Schmidt, Collette, Cajochen, & Peigneux (2007) found that time-of-day can affect performance on many cognitive tasks, regardless of physiological variables. We extend this literature in that we found a time-of-day effect for college students performing social cognitive tasks as well. These results must be interpreted cautiously because they may simply be demonstrating a true time-of-day effect—the tendency to perceive things differently at different times of day based on a multitude of variables, such as class schedule, social interaction times, food intake times, or stimulant use (to name a few)—that was not controlled for in this study; such a true time-of-day effect would apply to college students regardless of their chronotype or chronotype match to time-of-preference. Since these results suggest that our hypotheses may have been significant with more power, we can argue that social cognition may be affected by both the evening and by a personal history of social interactions biased towards evening times. The fact that the AM group rated these faces significantly lower at the high intensities rather than the low intensities, suggests that time-of-day becomes more critical for social cognition as expressive intensity increases. These results, together with those of Paradee et al. (2008) (who found a morning time-of-day effect for elderly patients performing emotion recognition tasks), suggest a true time-of-day effect for facial affect processing tasks. The time of day during which this effect occurs may change with age and chronotype.

Contributions

Overall, we found no significant differences between chronotypes or temporal preferences as a factor of facial affect processing. This suggests a few things. Despite the fact that eveningness may be a premorbid trait for depression, it seems as though eveningness is not a premorbid trait for social cognitive deficits, regardless of the relationship between eveningness and mood or of mood with social cognition. We did, however, find that college students generally perceive facial expressions more intensely during the evening than during the morning, which suggests that social cognitive functioning in college students is heightened during evening hours and possibly during chronotype peak arousal times.

We found significant relationships between increased negative mood and decreased social ease and confidence, yet we did not find any relationship between eveningness and mood, eveningness and social ease and confidence, or eveningness and facial affect processing. Although loosely, this may suggest that while one may not *feel* socially adept, they are not necessarily inadequate at processing faces; in this way, it may be important to distinguish between social anxiety and social cognition.

It is also important to distinguish between neural mechanisms. It is often the case that when a deficit in one cognitive area exists, deficits in related cognitive areas also exist. Usually, one or more deficits manifest together as a result of one overarching factor, such as depression, social anxiety, or brain damage. The reason this occurs may be due to a shared neural circuitry. In this case, based on the possibility that eveningness and mood or mood and social cognition may share neural circuitry, but that we did not find any link between eveningness and social cognition may be interpreted as eveningness and social cognition not sharing a neural circuitry.

As previously stated, the results of both of our hypotheses may imply that the concept of cognitive reserve is responsible for the lack of significant difference found between chronotypes and temporal preferences. For this reason, it may be important, when sampling from populations with greater cognitive reserve (i.e. college students or young adults), to increase the task difficulty in order to discriminate between two groups.

It is of course still possible that eveningness and social cognition are substantially related to one another. Another reason we did not find significance might have been due to the setting in which we conducted our experiments. The lack of ecological relevance of our study, or reduction in applicability to everyday life, may have been responsible for our design's failure to detect a difference between chronotypes and temporal preferences. These chronotype differences may only manifest themselves in the face of real human interactions, which often involve social anxiety and multimodal communication (which were mostly absent during the assessment). Thus, it is important when conducting research to strike a delicate balance between maintaining ecological relevance and controlling confounds.

Implications

Based on the results of this study, we offer a few implications for the college population and society at large. Since morningness is associated with positive characteristics—such as effort in school, efficiency of study time, conscientiousness, optimism, empathy, and general health—and since eveningness is strongly associated with negative characteristics—such as procrastination, risk-taking behavior, pessimism, and psychiatric illness—a potential method for alleviating negative traits could be to adjust one's sleeping habits or behaviors to more closely reflect those of a typical morning person. This can be implemented in a few ways: by taking melatonin pills (which induce sleep), by avoiding certain activities generally associated with eveningness—such as socializing in the evening, consuming alcohol and nicotine, or sleeping later and less—or by performing certain activities generally associated with morningness—such as socializing in the day time, exercising regularly, or exposing oneself to adequate sunlight. It is important to note, however, that drastic changes to one's sleep schedule or endogenous activity patterns may trigger or exacerbate undue stress and negative mood.

Obtaining significant results for our main hypotheses might benefit evening-oriented and socially inept populations. Mental health professionals would be more aware of the connections between chronotype and social cognitive dysfunction; this may lead to early intervention programs to combat social ineptitude in evening-oriented patients. In addition, people with social anxiety or facial affect processing deficits could know to schedule social interactions during times of preferred activity. College students in particular could schedule job interviews or classes during their optimal times of performance.

Limitations and Future Directions

The present research should be considered with respect to a number of limitations. We acquired a relatively small sample size; future studies should recruit larger sample sizes to increase statistical power and to gain a more accurate picture of the intended population. We also included and assigned participants to a test time *a priori* of knowing their chronotype; in the future, chronotype should be determined before admission as a participant to ensure a sufficient amount of each chronotype and to counterbalance chronotypes across different times of testing. We did not adequately measure or control for mood state, psychiatric illness, cognitive impairment, prosopagnosia and related disorders, irregular sleep patterns, drug use, biochemical levels, personality, work/class schedules, handedness, temperature of the assessment room, weather, or level of instruction comprehension; future studies should take these variables into consideration when testing the college population, chronotype, mood, or facial affect processing. Lastly, our sample was not perfectly random.

We offer some additional relevant suggestions for future researchers in the field. In particular, we propose changes to the manner in which chronotype is assessed. While the MEQ has been shown to be a highly reliable measure of chronotype, its reliability might increase if the questions were based less on participants' preference for certain activities, and more on their actual lifestyles. For example, in addition to a question asking what time a participant *prefers* to wake up (Appendix A, #1), a question asking about the *actual* time a participant wakes up in the absence of any daily commitments would more accurately indicate a participants' chronotype. In the same breath, a more reliable measure of chronotype altogether would be one including physiological data of participants, detailed amounts of daily light exposure (which can be measured by specific gadgets worn on the body throughout the day, such as the Daysimeter), and sleep logs.

Brain imaging would also shed more light on chronotype differences. With the use of fMRI, researchers would be able to determine whether evening and morning types show differential levels of activation in response to facial expressions or other social stimuli. Comparisons between clinically depressed patients and evening-oriented individuals may also shed light on the factors of eveningness that contribute to depression or that may induce risk for depressive symptoms. Lastly, comparisons between brains of depressed owls and depressed larks may also enlighten researchers to the differences between the two chronotypes, and even possibly distinguish between different forms of depression (belonging to larks and owls) with unique characteristics or patterns of activation for each.

Performing more experiments comparing chronotypes on facial affect processing is necessary. First, it is important to replicate the current study with more statistical power. Second, future researchers could determine how chronotypes differ based on different facial affect processing tasks, such valence judgment and memory for certain facial expressions, among others. It would also be interesting to determine how chronotypes differ in emotion recognition at various levels of intensity. A repeated measures design—in which morning-type college students are tested in the evening and then in the morning and vice versa—would increase our understanding of the time-of-day effect in college students performing social cognitive tasks. Depressed patients show reduced accuracy for faces displayed for short durations; measuring reaction times to emotional rating tasks between chronotypes would also increase awareness of the relationship between chronotype and social cognition. Additionally, since chronotype and depression seem to change as a function of age, it would be interesting to learn how differently aged members of the same chronotype compare in the same facial affect processing tasks. Lastly, future researchers could expand their testing of chronotype and social cognition by experimenting with different forms of signaling, such as vocal, gestural, or tactile communication as well.

Summary and Conclusions

In conclusion, our predictions—that evening types and non-preferred time types would rate facial expressions with lower intensity than morning types and preferred time types, respectively—were not supported. In addition to the fact that these groups did not significantly differ in emotion recognition accuracy, these results overall indicate that a distinct relationship between chronotype and social cognition may not exist. However, our exploratory analysis suggests that college students may demonstrate more social adeptness during the evening than during the morning. Due to our small sample sizes, inconclusive results, and unexpected finding that college students demonstrate greater sensitivity to facial expressions at the high range of intensity, future studies must be conducted in order to determine whether chronotype and time-of-day are related to social cognition. In order to improve the lives of patients who suffer from mood or social cognitive disorders, it is important that we first understand the relationships between chronotype, time-of-day, and our interpersonal lives.

References

Adolphs, R. (2008). Fear, faces, and the human amygdala. *Current Opinion in Neurobiology, 18,* 166-172.

Akerstedt, T., & Froberg, J. E. (1976). Interindividual differences in circadian patterns of catecholamine excretion, body temperature, performance, and subjective arousal. *Biological Psychology, 4,* 277-292.

Aschoff, J., Fatranska, M., Giedke, H., Doerr, P., Stamm, D., & Wisser, H. (1971). Human circadian rhythms in continuous darkness: Entrainment by social cues. *Science, 171(3967)*, 213-215.

Bailey, S. L., & Heitkemper, M. M. (2001). Circadian rhythmicity of cortisol and body temperature: Morningness-eveningness effects. *Chronobiology International, 18(2),* 249-261.

Baker, R. W., & Siryk. B. (1989). SACQ: Student adaptation to college questionnaire manual. Los Angeles: Western Psychological Services.

Beck, A. T., Rush, A. J., Shaw, B. F., Emery, G. (1979). Cognitive therapy of depression. New York: Guilford Press.

Bourke, C., Douglas, K., & Porter, R. (2010). Processing of facial emotion expression in major depression: A review. *Australia and New Zealand Journal of Psychiatry, 44*, 681-696.

Cavanagh, J., & Geisler, M. W. (2006). Mood effects on the ERP processing of emotional intensity in faces: A P3 investigation with depressed students. *International Journal of Psychophysiology, 60(1),* 27-33.

Cellerino, A., Borghetti, D., & Sartucci, F. (2004). Sex differences in face gender recognition in humans. *Brain Research Bulletin, 63,* 443-449.

Chelminski, I., Ferraro, F. R., Petros, T., & Plaud, J. J. (1997). Horne and Ostberg questionnaire: A score distribution in a large sample of young adults. *Personality and Individual Differences, 23(4),* 647-652.

Chelminski, I., Ferraro, F. R., Petros, T. V., & Plaud, J. J. (1999). An analysis of the "eveningness-morningness" dimension in "depressive" college students. *Journal of Affective Disorders, 52,* 19–29.

Csukly, G., Czobor, P., Erika, S., Barnabas, T., & Lajos, S. (2009). Facial expression recognition in depressed subjects: The impact of intensity level and arousal dimension. *Journal of Nervous and Mental Disease, 197(2),* 98-103.

Darwin, C. (1896). *The expression of the emotions in man and animals.* New York, NY: D. Appleton and Company.

Dement W. C., & Vaughan, C. (1999). The promise of sleep. New York, NY: Dell Publishing.

Drennan, M. D., Klauber, M. R., Kripke, D. F., & Goyette, L. M. (1991). The effects of depression and age on the Horne-Ostberg morningness-eveningness score. *Journal of Affective Disorders, 23,* 93-98.

Ekman, P., Friesen W. V., O'Sullivan, M., Chan, A., Diacoyanni-Tarlatzis, I., Heider, K., …Tzavaras, A. (1987). Universals and cultural differences in the judgments of facial expressions of emotion. *Journal of Personality and Social Psychology, 53(4),* 712-717.

Elfenbein, H. A., & Nalini, A. (2003). When familiarity breeds accuracy: Cultural exposure and facial emotion recognition. *Journal of Personality and Social Psychology, 85(2),* 276-290.

Emery, N. J. (2000). The eyes have it: The neuroethology, function and evolution of social gaze. *Neuroscience and Biobehavioral Reviews, 24*, 581-604.

Fales, C. L., Barch, D. M., Rundle, M. M., Mintun, M. A., Snyder, A. Z., Cohen, J. D.,…Sheline, Y. I. (2008). Altered emotional interference processing in affective and cognitive control brain circuitry in major depression. *Biological Psychiatry, 63,* 377-384.

Giglio, L. M. F., Magalhaes, P. V. S., Andersen, M. L., Walz, J. C., Jakobson, L., & Kapczinski, F. (2009). Circadian preference in bipolar disorder. *Sleep Breath, 14,* 153-155.

Hadj-Bouziane, F., Bell, A. H., Knusten, T. A., Ungerleider, L. G., & Tootell, R. B. H. (2008). Perception of emotional expressions is independent of face selectivity in monkey inferior temporal cortex. *Proceedings of the National Academy of Sciences, 105(14),* 5591-5596.

Hidalgo, M. P., Caumo, W., Posser, M., Coccaro, S. B., Camozzato, A. L., & Chaves, M. L. F. (2009). Relationship between depressive mood and chronotype in healthy subjects. *Psychiatry and Clinical Neurosciences, 63*, 283-290.

Hoddes, E., Zarcone, V., Smythe, H., Phillips, R., & Dement, W. C. (1973). Quantification of sleepiness: a new approach. *Psychophysiology, 10*, 431-436.

Hoffman, S. G., Suvak. M., & Litz, B. T. (2006). Sex differences in face recognition and influence of facial affect. *Personality and Individual Differences, 40,* 1683-1690.

Horne, J. A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology, 4*, 97-110.

Horne, J. A., & Ostberg, O. (1977). Individual differences in human circadian rhythms. *Biological Psychology, 5,* 179-190.

Kerkhof, G. A. (1985). Inter-individual differences in the human circadian system: A review. *Biological Psychology, 20*, 83-112.

Kitamura, S., Hida, A., Watanabe, M., Enomoto, M., Aritake-Okada, S., Moriguchi,Y., …Mishima, K. (2010). Evening preference is related to the incidence of depressive states independent of sleep-wake conditions. *Chronobiology International, 27,* 1797-1812.

Kuraoka, K., & Nakamura, K. (2006). Responses of single neurons in monkey amygdala to facial and vocal emotions. *Journal of Neurophysiology, 97,* 1379-1387.

Lavie, P. (1996). The enchanted world of sleep. Harrisonburg, VA: Yale University Press.

Levandovski, R., Dantas, G., Fernandes, L. C., Caumo, W., Torres, I., Roenneberg, T., Hidalgo, M.P., & Allenbrandt, K. V. (2011). Depression scores associate with chronotype and social jetlag in a rural population. *Chronobiology International, 28(9),* 771-778.

Liu, Z., Xu, C., Xu, Y., Wang, Y., Zhao, B., Lv, Y., …Du, C. (2010). Decreased regional homogeneity in insula and cerebellum: A resting-state fMRI study in patients with major depression and subjects at high risk for major depression. *Psychiatry Research: Neuroimaging, 182(3),* 211-215.

Martin, P. (2002). Morpheus undressed. *Counting sheep: The science and pleasures of sleep and dreams* (pp. 113-131). New York, NY: St. Martin's Press.

Matsumoto, D. (1993). Ethnic differences in affect intensity, emotion judgments, display rule attitudes, and self-reported emotional expression in an American sample. *Motivation and Emotion, 17(2),* 107-123.

Matsumoto, D. & Assar, M. (1992). The effects of language on judgments of universal facial expression of emotion. *Journal of Nonverbal Behavior, 16(2)*, 85-99.

Mistlberger, R. E., & Skene, D. J. (2005). Nonphotic entrainment in humans? *Journal of Biological Rhythms, 20(4)*, 339-352.

Mograss, M. A., Guillem, F., & Stickgold, R. (2010). Individual differences in face recognition memory: Comparison among habitual short, average, and long sleepers. *Behavioral Brain Research,* 576-583.

Montagne, B., Kessels, R. P. C., Frigerio, E., De Haan, E. H. F., & Perrett, D. L. (2005). Sex differences in the perception of affective facial expressions: Do men really lack emotional sensitivity? *Cognitive Processes, 6,* 136-141.

Monteleone, P., & Maj, M. (2008). The circadian basis of mood disorders: Recent developments and treatment implications. *European Neuropsychopharmacology, 18,* 701-711.

Moore, R. Y. (1997). Circadian rhythms: Basic neurobiology and clinical applications. *Annual Review of Medicine, 48*, 253-266.

Mrosovsky, N. (1988). Phase response curves for social entrainment. *Journal of Comparative Physiology A: Neuroethology, Sensory, Neural, and Behavioral Physiology, 162(1),* 35-46.

Ostberg, O. (1973). Circadian rhythm of food intake and oral temperature in "morning" and "evening" groups of individuals. *Ergonomics, 16*, 203-209.

Palermo, R., & Coltheart, M. (2004). Photographs of facial expressions: Accuracy, response times, and ratings of intensity. *Behavior Research Methods, Instruments, & Computers, 36(4),* 634-638.

Paradee, C. V., Rapport, L. J., Lumley, M. A., Hanks, R. A., Langenecker, S. A., & Whitman, R. D. (2008). Circadian preference and facial emotion recognition among rehabilitation inpatients. *Rehabilitation Psychology, 53(1),* 46-53.

Persad, S. M., & Polivy, J. (1993). Differences between depressed and nondepressed individuals in the recognition of and response to facial emotion cues. *Journal of Abnormal Psychology, 102(3),* 358-368.

Rehnman, J., & Herlitz, A. (2006). Higher face recognition ability in girls: Magnified by own-sex and own-ethnicity bias. *Memory, 14(3),* 289-296.

Roenneberg, T., & Foster, R. G. (1997). Twilight times: Light and the circadian system. *Photochemistry and Photobiology, 66(5),* 549-561.

Roenneberg, T., Wirz-Justice, A., & Merrow, M. (2003). Life between clocks: Daily temporal patterns of human chronotypes. *Journal of Biological Rhythms, 18*, 80-90.

Rolls, E. T., Critchley, H. D., Browning, A. S., & Inoue, K. (2006). Face-selective and auditory neurons in the primate orbitofrontal cortex. *Experimental Brain Research, 170,* 74-87.

Sangrigoli, C., Pallier, Argenti, A.M., Ventureyra, V.A.G., de Schonen, S. (2005). Reversibility of the other-race effect in face recognition during childhood. *Psychological Science, 16(6),* 440-444.

Schmidt, C., Collette, F., Cajochen, C., & Peigneux, P. (2007). A time to think: circadian rhythms in human cognition. *Cognitive Neuropsychology, 24(7)*, 755-789.

Selvi, Y., Aydin, A., Atli, A., Boysan, M., Selvi, F., & Besiroglu, L. (2011). Chronotype differences in suicidal behavior and impulsivity among suicide attempters. *Chronobiology International, 28(2),* 170-175.

Selvi, Y., Gulec, M., Agargun, M. Y., & Besiroglu, L. (2007). Mood changes after sleep deprivation in morningness-eveningness chronotypes in healthy individuals. *Journal of Sleep Research, 16,* 241-244.

Sinha, P., Balas, B, Ostrovsky, Y., & Russel, R. (2006). Face recognition by humans: nineteen results all computer vision researchers should know about. *Proceedings of the IEEE, 94(11), 1948-1962.*

Sheline, Y. I., Mittler, B. L., & Mintun, M. A. (2002). The hippocampus and depression. *European Psychiatry, 17(3),* 300-305.

Stephan, F. (2002). The "other" circadian system: Food as a zeitgeber. *Journal of Biological Rhythms 17(4)*, 284-292.

Stunkard, A. J., & Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of Psychosomatic Research, 29(1),* 71-83.

Sugase, Y., Yamane, S., Ueno, S., & Kawano, K. (1999). Global and fine information coded by single neurons in the temporal visual cortex. *Nature, 400,* 869-873.

Surguladze, S. A., Young, A. W., Senior, C., Brebion, G., Travis, M. J., & Philips, M. L. (2004). Recognition accuracy and response bias to happy and sad facial expressions in patients with major depressions. *Neuropsychology, 18(2),* 212-218.

SurveyMonkey. (2011). Smart Survey Design. Retrieved from http://s3.amazonaws.com/ SurveyMonkeyFiles/SmartSurvey.pdf.

Tottenham, N., Tanaka, J., Leon, A. C., McCarry, T., Nurse, M., Hare, T.A., Marcus, D.J., Westerlund, A., Casey, B.J., Nelson, C.A. (2009). The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research, 168(3),* 242-249.

Tovee, M. J. (1996). Face recognition and interpretation. *An introduction to the visual system* (pp. 132-141). Edinburgh, UK: Cambridge University Press.

Treiblmaier, H., & Filzmoser, P. (2009). Benefits from using continuous rating scales in online survey research. Institut f. Statistik u. Wahrscheinlichkeitstheorie, Vienna University of Technology, Vienna.

Tsaousis, I. (2010). Circadian preferences and personality traits: A meta-analysis. *European Journal of Personality, 24,* 356-373.

Tucker, A. & Stern, Y. (2011). Cognitive reserve in aging. *Current Alzheimer Research, 8*(3), 1-7.

Uusitalo, A., Ahonen, J. P., Gorski, P., Tuomisto, M., & Turjanmaa, V. (1988). Does the biorhythm of morningness or eveningness predict the arterial blood pressure level? *Annals of Clinical Research, 20(48),* 51-53.

Van der Helm, E., Gujar, N., & Walker, M. P. (2010). Sleep deprivation impairs the accurate recognition of human emotions. *SLEEP, 33*(3), 335-342.

Vandewalle, G., Maquet, P., & Dijk, D-J. (2009). Light as a modulator of cognitive brain function. *Trends in Cognitive Sciences 13(10)*, 429-438.

Walker, P. & Tanaka, J. (2003). An encoding advantage for own-race versus other-race faces. *Perception, 32,* 1117-1125.

Yamanaka, Y., Hashimoto, S., Tanahashi, Y., Nishide, S., Honma, S., & Honma, K. (2009). Physical exercise accelerates reentrainment of human sleep-wake cycle but not of plasma melatonin rhythm to 8-h phase advanced sleep schedule. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 29(8)*, 681-691.

Table 1

Descriptive Statistics of Participants' MEQ Scores

	Males	Females	Total
Number of Participants	18	51	69
Mean score	42.83	44.45	44.03
S.D.	8.46	8.61	8.54
Range	26-56	22-63	22-63
Morning	0	2	2
Intermediate	10	33	43
Evening	8	16	24

Table 2

Descriptive Statistics of Participants for Evening Type vs. Non-Evening Type

	Evening	Non-Evening
Number of Participants	24	24
Mean MEQ Score	35.0	53.0
MEQ Score Range	22-41	48-63
Number of Males	8	6
Number of Females	16	18
Mean Age	19.3	19.8
Number of Paid Subjects	12	12
Number of Non-paid Subjects	12	12
Number of AM Test-time	10	11
Number of PM Test-time	14	13
Mean SSS Score	2.67	2.65

Table 3

Repeated Measures Analysis of Variance for Chronotype and Stimulus Intensity Ratings

Source	*SS*	*df*	*MS*	*F*	*p*	Effect size
All Emotions						
Intensity (I)	1043.64	1.20	867.03	310.58	<.001	.871
Chronotype (C)	2.04	1.00	2.04	0.30	.58	.007
I X C	1.17	1.20	0.97	0.35	.60	.007
Angry						
Intensity (I)	1106.72	1.75	634.38	237.68	<.001	.838
Chronotype (C)	3.04	1.00	3.04	0.28	.60	.006
I X C	1.47	1.75	0.85	0.32	.70	.007
Happy						
Intensity (I)	837.03	1.44	581.74	157.54	<.001	.774
Chronotype (C)	6.29	1.00	6.29	0.82	.37	.018
I X C	6.29	1.44	4.37	1.18	.30	.025
Sad						
Intensity (I)	893.04	1.30	687.01	135.31	<.001	.746
Chronotype (C)	0.07	1.00	0.07	0.01	.93	<.001
I X C	2.02	1.30	687.01	0.31	.64	.007
Surprised						
Intensity (I)	1428.59	1.86	767.03	405.39	<.001	.898
Chronotype (C)	1.43	1.00	1.43	0.15	.70	.003
I X C	1.15	1.86	0.62	0.33	.71	.007

Overall Means	Evening Group	Non-evening Group	Total
All Emotions	4.59	4.45	4.52
Angry	4.51	4.34	4.43
Happy	3.93	3.69	3.81
Sad	4.56	4.54	4.55
Surprised	5.36	5.25	5.30

Table 4

Descriptive Statistics of Participants for Preferred Time vs. Non-Preferred Time

	Preferred	Non-Preferred
Number of Participants	15	11
Mean MEQ Score	39.1	34.1
MEQ Score Range	27-63	22-60
Number of Males	5	3
Number of Females	10	8
Mean Age	19.2	19.5
Number of Paid Subjects	4	5
Number of Non-paid Subjects	11	6
Number of AM Test-time	1	10
Number of PM Test-time	14	1
Mean SSS Score	2.43	3.05

Table 5

Repeated Measures Analysis of Variance for Preference and Stimulus Intensity Ratings

Source	*SS*	*df*	*MS*	*F*	*p*	Effect size
All Emotions						
Intensity (I)	559.36	1.19	469.24	164.96	<.001	.873
Preference (P)	11.50	1.00	11.50	1.51	.23	.059
I X P	3.07	1.19	2.58	0.91	.37	.036
Angry						
Intensity (I)	585.41	1.80	325.96	127.01	<.001	.841
Preference (P)	12.84	1.00	12.84	1.16	.29	.046
I X P	2.40	1.80	1.33	0.52	.58	.021
Happy						
Intensity (I)	480.21	1.49	322.07	113.08	<.001	.825
Preference (P)	11.65	1.00	11.65	1.29	.27	.051
I X P	7.22	1.49	4.84	1.70	.20	.066
Sad						
Intensity (I)	465.72	1.23	377.61	58.32	<.001	.708
Preference (P)	15.86	1.00	15.86	1.71	.20	<.067
I X P	3.32	1.23	2.69	0.42	.57	.017
Surprised						
Intensity (I)	747.69	1.85	405.33	203.21	<.001	.894
Preference (P)	6.68	1.00	6.68	0.55	.47	.022
I X P	5.20	1.85	2.82	1.41	.25	.056

Overall Means	Preferred Group	Non-preferred Group	Total
All Emotions	4.70	4.25	4.51
Angry	4.60	4.13	4.40
Happy	4.07	3.62	3.88
Sad	4.72	4.19	4.49
Surprised	5.43	5.09	5.30

Table 6

Descriptive Statistics of Participants for Evening Test Time vs. Morning Test Time

	Evening Test Time	Morning Test Time
Number of Participants	36	33
Mean MEQ Score	44.4	43.6
MEQ Score Range	27-60	22-63
Number of Males	9	9
Number of Females	27	24
Mean Age	19.3	19.9
Number of Paid Subjects	12	15
Number of Non-paid Subjects	24	18
Number of Preferred Time Subjects	14	1
Number of Non-preferred Time Subjects	1	10
Mean SSS Score	2.54	2.91

Table 7

Repeated Measures Analysis of Variance for Time of Testing and Stimulus Intensity Ratings

Source	*SS*	*df*	*MS*	*F*	*p*	Effect size
All Emotions						
Intensity (I)	1632.74	1.24	1318.22	548.59	<.001	.891
Time (T)	24.27	1	24.27	4.31	.042	.060
I X T	11.36	1.24	9.17	3.82	.045	.054
Angry						
Intensity (I)	1719.94	1.81	949.42	382.71	<.001	.851
Time (T)	42.57	1	42.57	4.37	.040	.061
I X T	4.31	1.81	2.38	.96	.379	.014
Happy						
Intensity (I)	1369.72	1.54	889.05	292.46	<.001	.814
Time (T)	5.91	1	5.91	.85	.361	.012
I X T	13.14	1.54	8.53	2.81	.079	.040
Sad						
Intensity (I)	1391.71	1.45	959.97	238.80	<.001	.781
Time (T)	52.41	1	52.41	6.84	.011	.093
I X T	30.36	1.45	20.94	5.21	.014	.072
Surprised						
Intensity (I)	2180.44	1.89	1152.52	630.35	<.001	.904
Time (T)	12.33	1	12.33	1.42	.238	.021
I X T	8.05	1.89	4.25	2.33	.105	.034

Overall Means	Evening Group	Morning Group	Total
All Emotions	4.76	4.36	4.57
Angry	4.66	4.14	4.41
Happy	3.96	3.77	3.87
Sad	4.82	4.24	4.55
Surprised	5.57	5.29	5.43

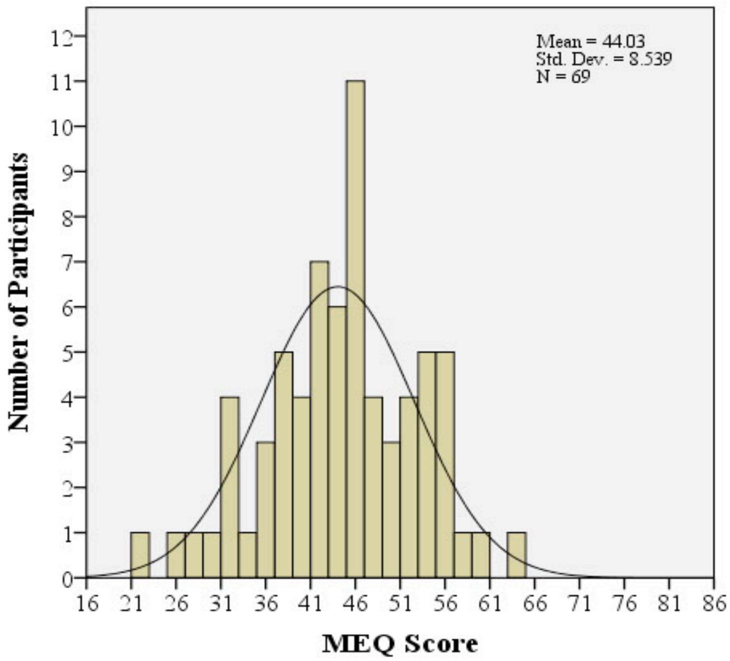

Figure 1. Frequency distribution of participants' MEQ scores. From left (16) to right (86) is eveningness to morningness.

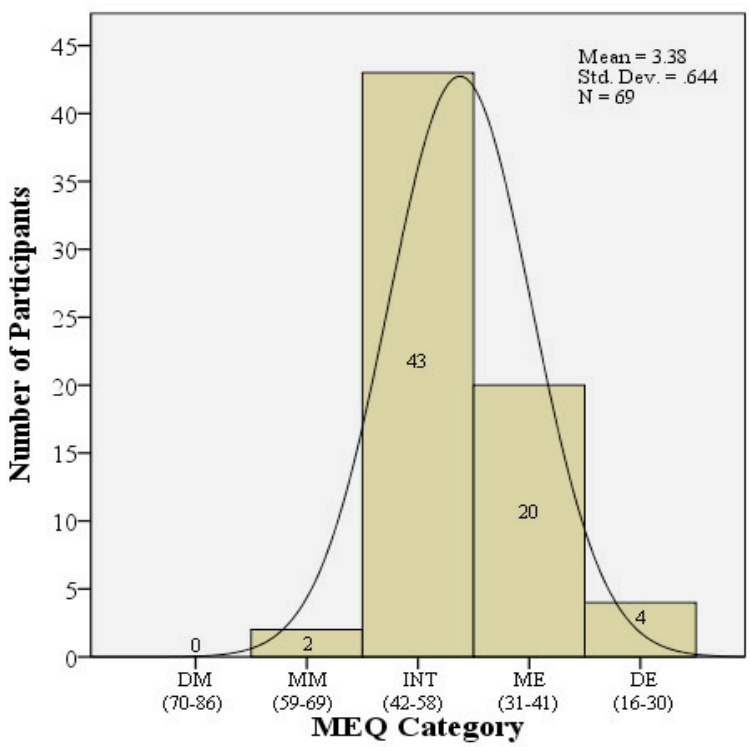

Figure 2. Frequency distribution of participant's MEQ scores into five categories. Below each category is the range of MEQ scores that fall within. DM = Definite Morning; MM = Moderate Morning; INT = Intermediate; ME = Moderate Evening; DE = Definite Evening.

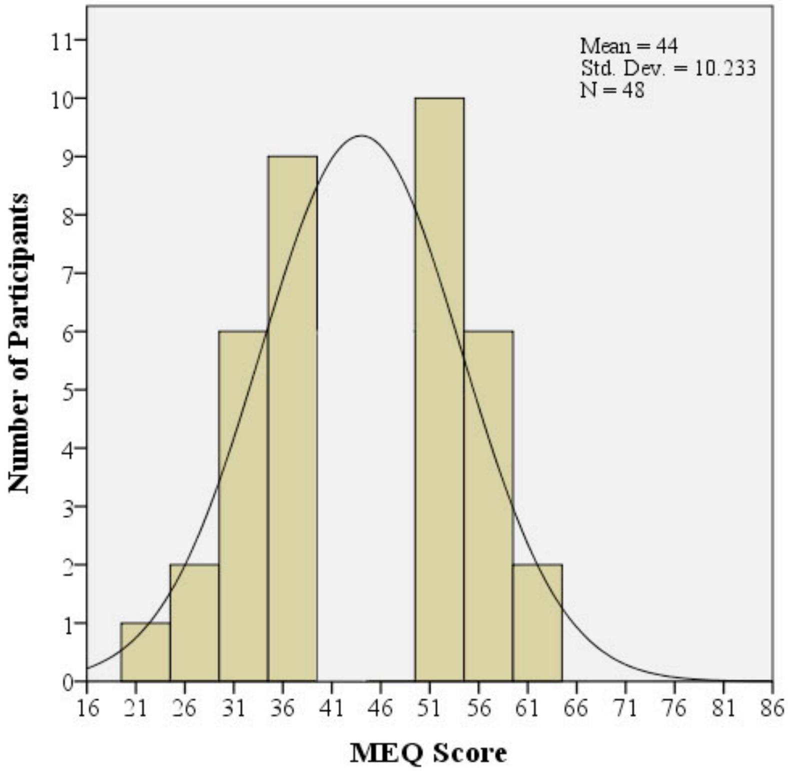

Figure 3. Frequency distribution of participants' MEQ scores into Evening vs. Non-Evening groups. We created these two groups with the 24 participants' that had the most extreme scores on either side of the spectrum and excluded the 21 central scores.

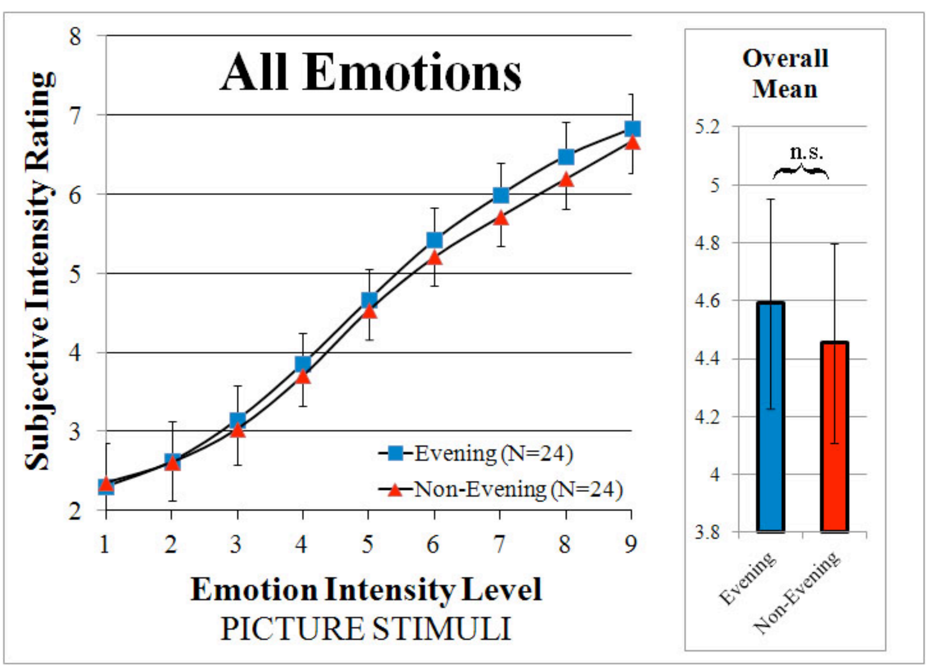

Figure 4. Subjective Intensity Ratings of All Emotions Combined for Evening Types and Non-Evening Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

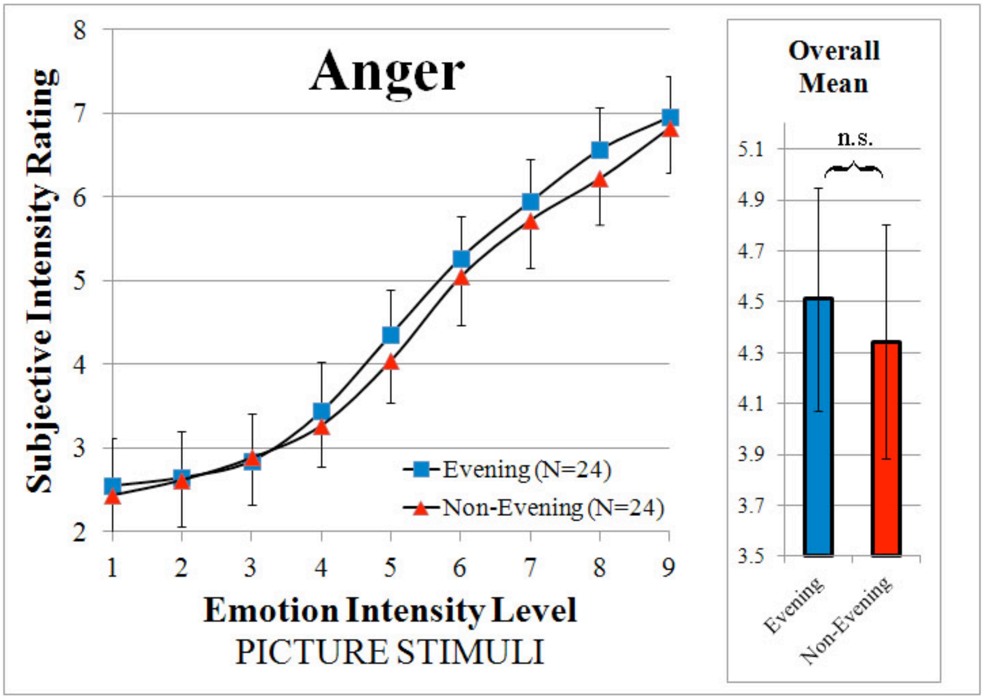

Figure 5. Subjective Intensity Ratings of Angry Faces for Evening Types and Non-Evening Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

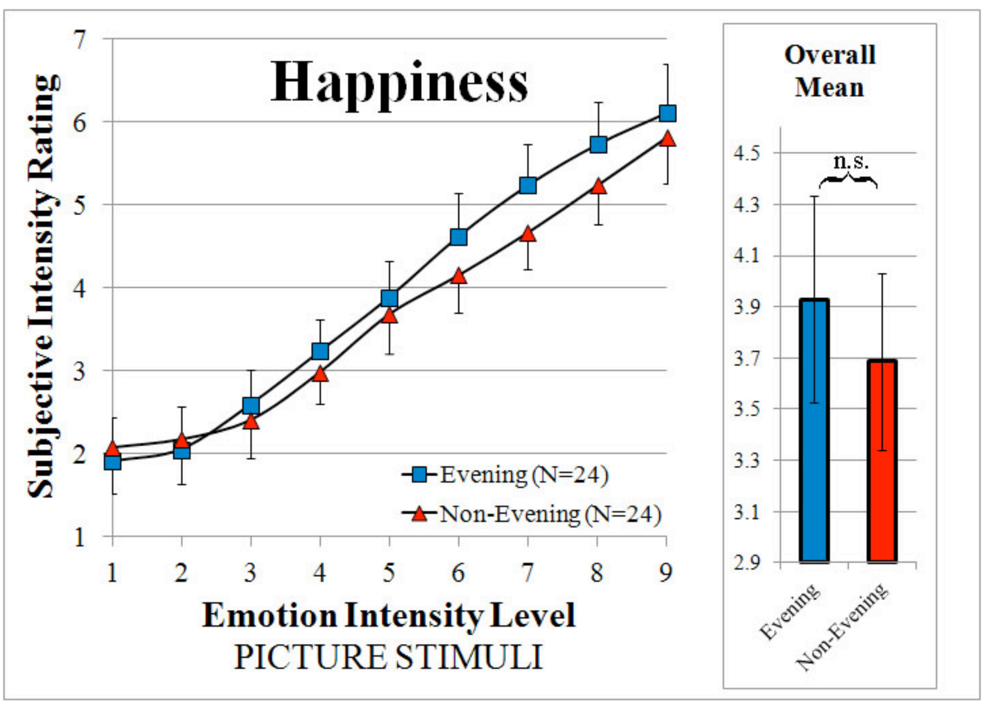

Figure 6. Subjective Intensity Ratings of Happy Faces for Evening Types and Non-Evening Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

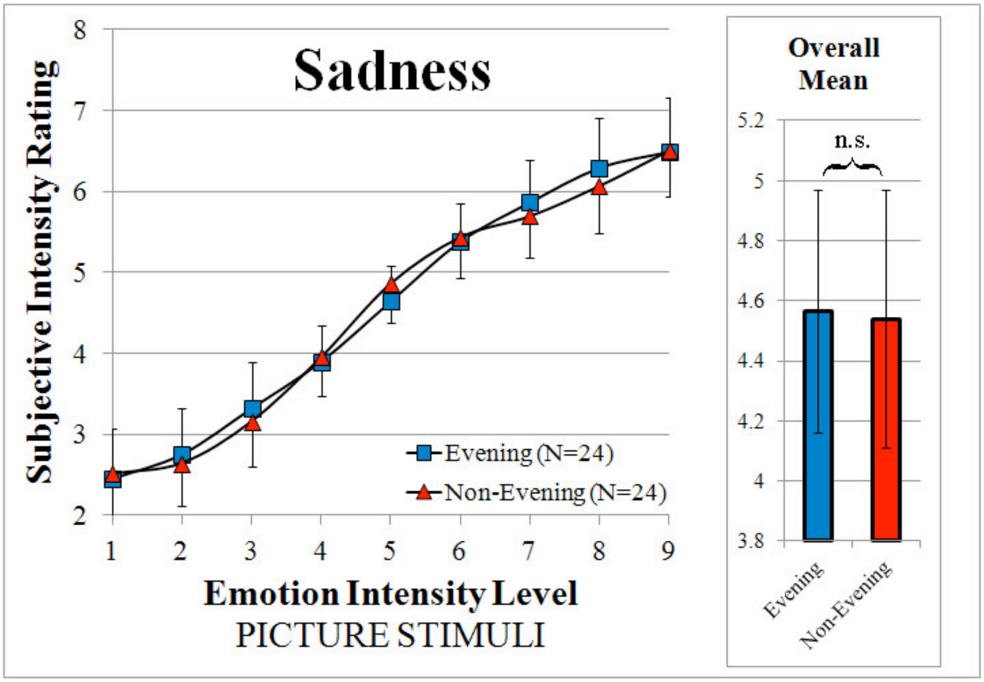

Figure 7. Subjective Intensity Ratings of Sad Faces for Evening Types and Non-Evening Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

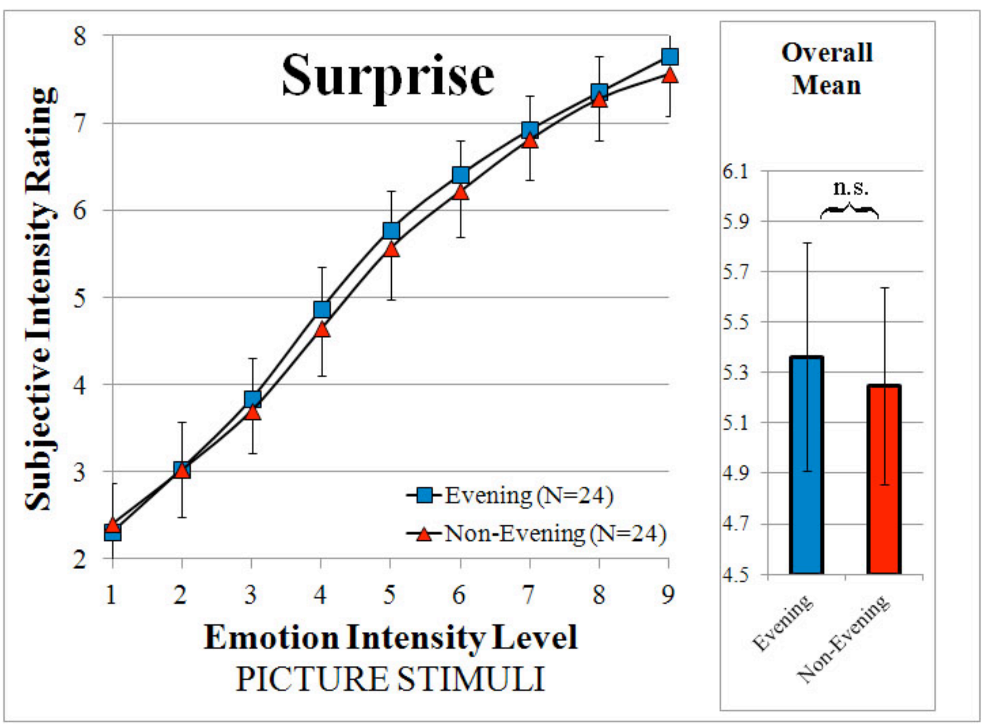

Figure 8. Subjective Intensity Ratings of Surprised Faces for Evening Types and Non-Evening Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

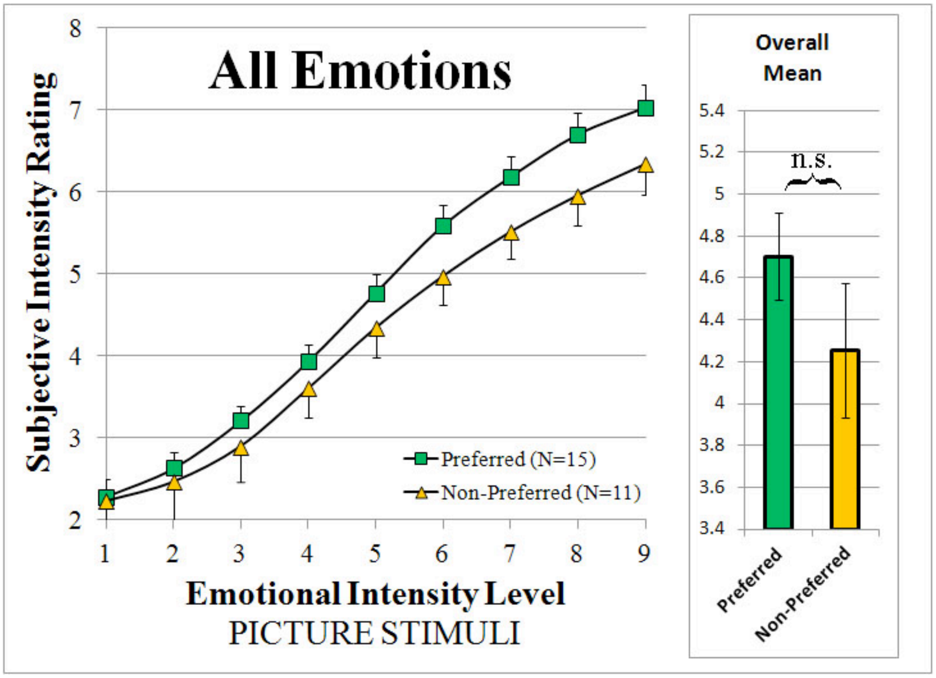

Figure 9. Subjective Intensity Ratings of All Emotions Combined for Preferred Types and Non-Preferred Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

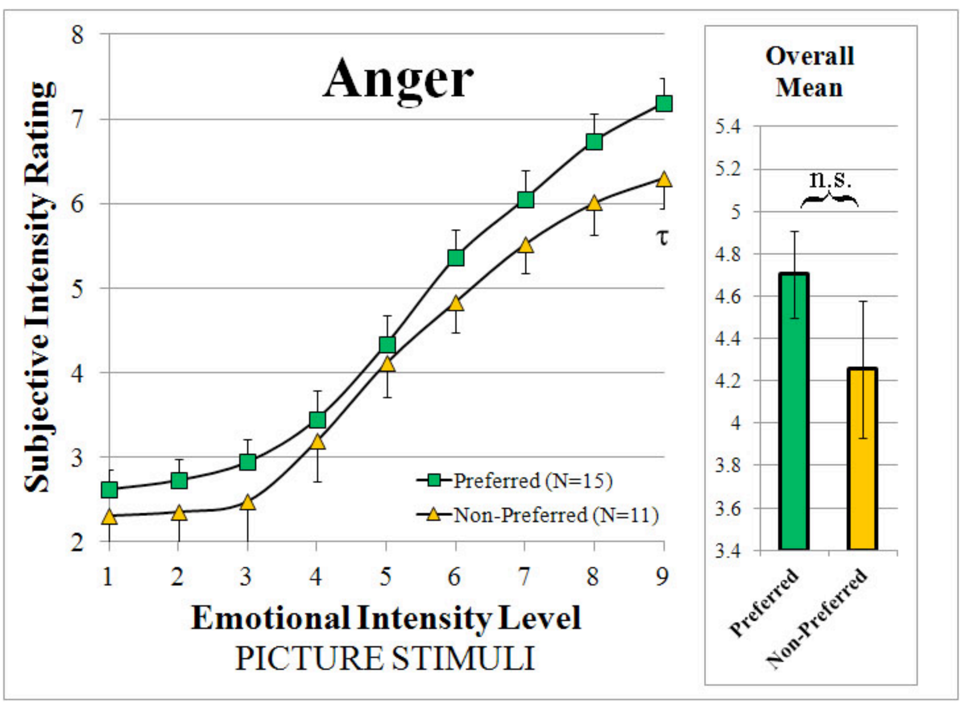

Figure 10. Subjective Intensity Ratings of Angry Faces for Preferred Types and Non-Preferred Types; Overall Mean Comparison. **τ**P < .08; n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

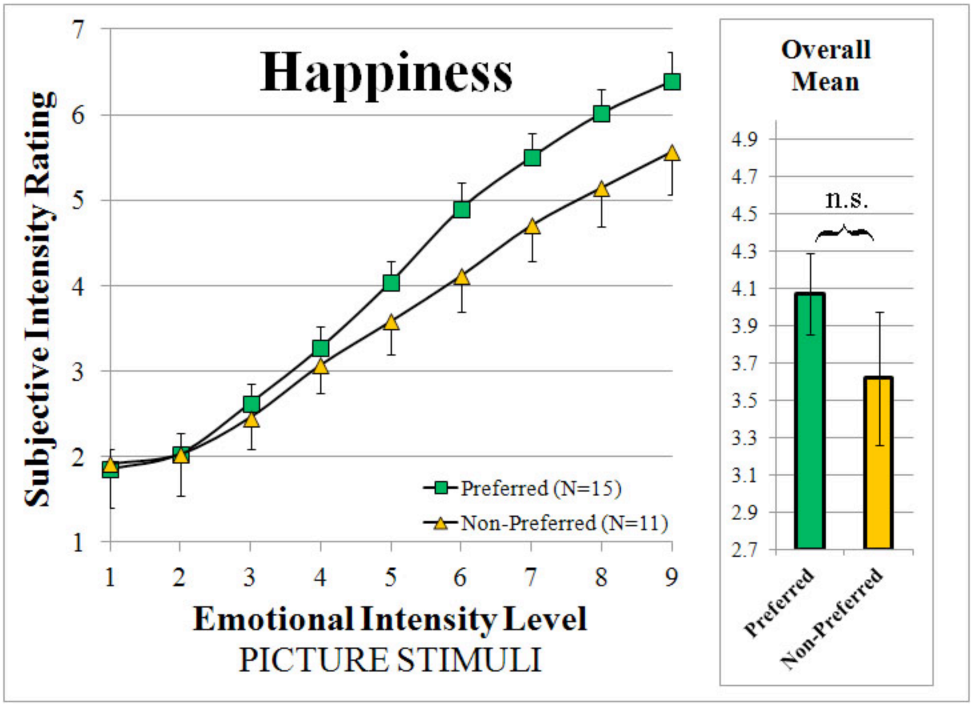

Figure 11. Subjective Intensity Ratings of Happy Faces for Preferred Types and Non-Preferred Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

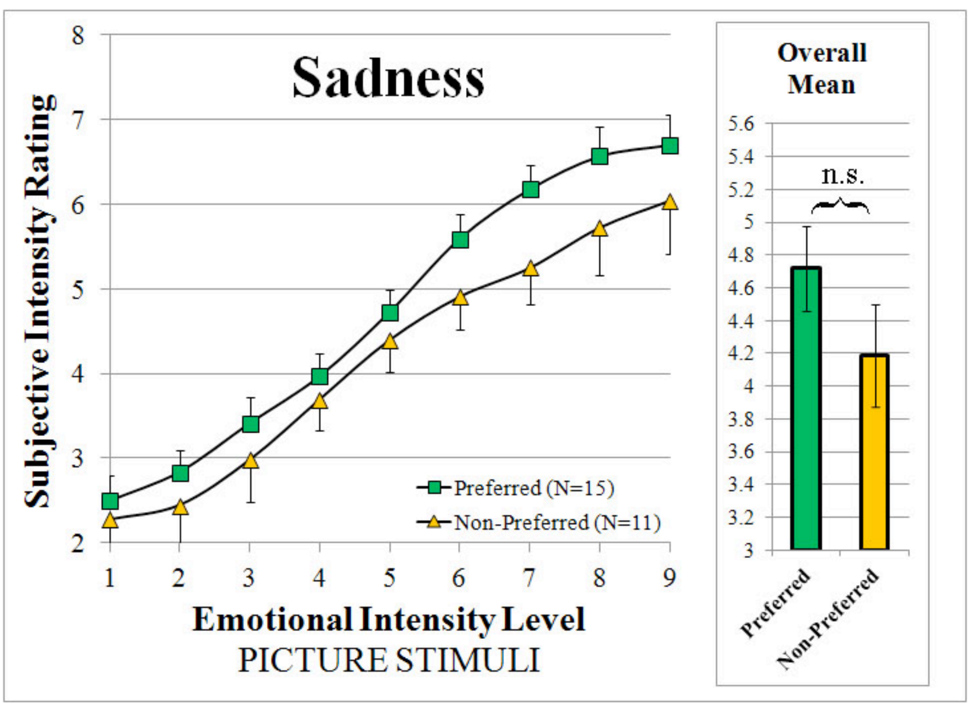

Figure 12. Subjective Intensity Ratings of Sad Faces for Preferred Types and Non-Preferred Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

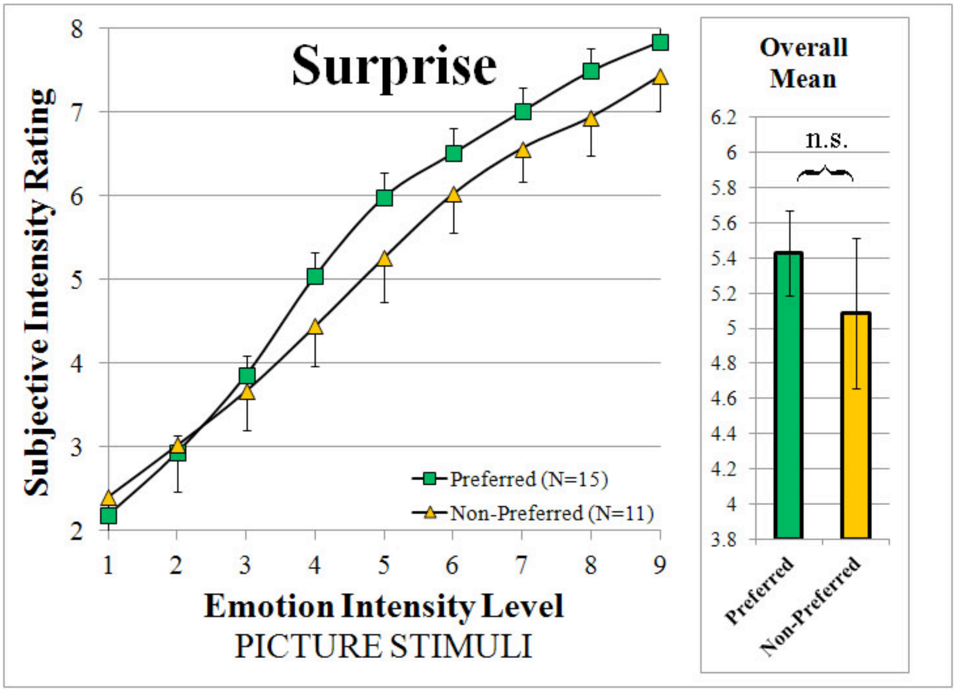

Figure 13. Subjective Intensity Ratings of Surprised Faces for Preferred Types and Non-Preferred Types; Overall Mean Comparison. n.s. = Nonsignificant. Error bars represent 1 standard error of the mean.

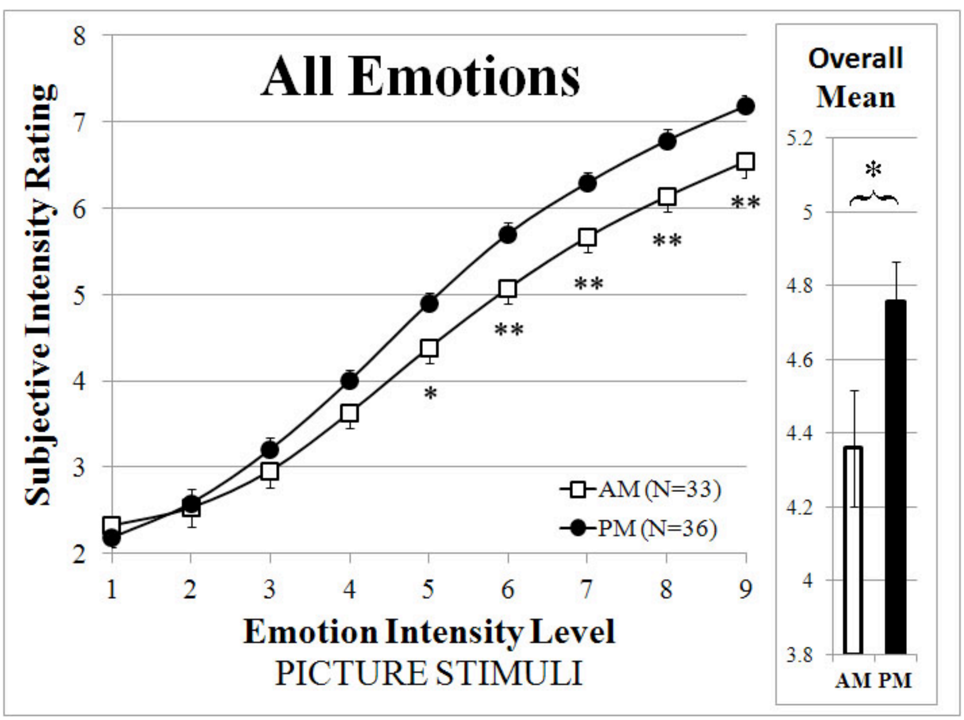

Figure 14. Subjective Intensity Ratings of All Emotions Combined for Participants Tested in the Morning and the Evening; Overall Mean Comparison. *P < .05; **P < .01. Error bars represent 1 standard error of the mean.

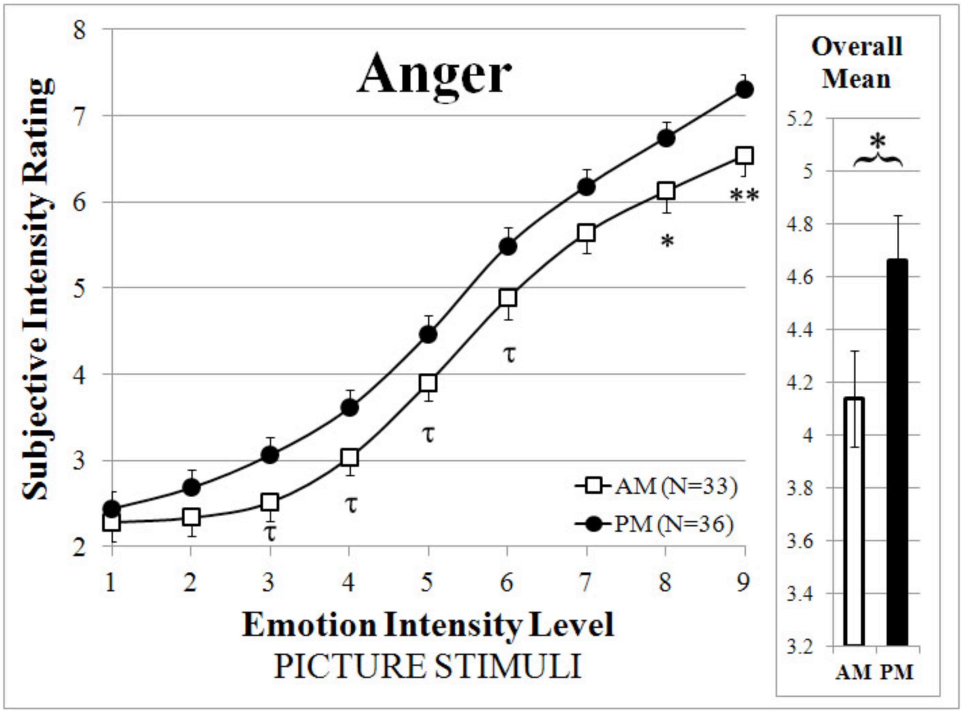

Figure 15. Subjective Intensity Ratings of Angry Faces for Participants Tested in the Morning and the Evening; Overall Mean Comparison. **τ**P < .08; *P < .05; **P < .01. Error bars represent 1 standard error of the mean.

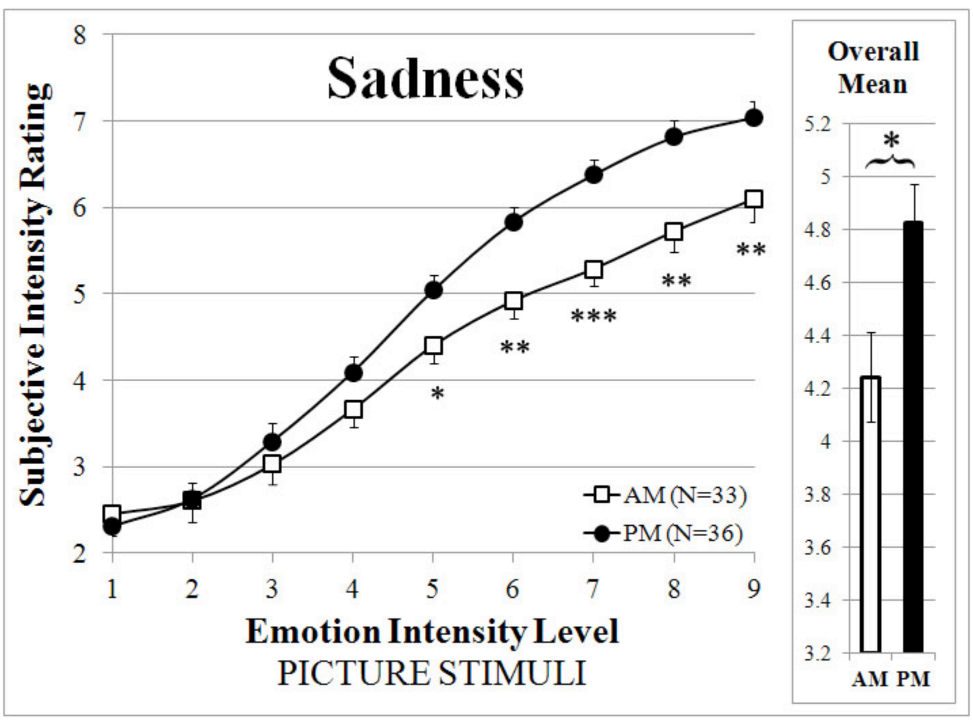

Figure 16. Subjective Intensity Ratings of Angry Faces for Participants Tested in the Morning and the Evening; Overall Mean Comparison. *P < .05; **P < .01; ***P < .001. Error bars represent 1 standard error of the mean.

Appendix A
Morningness-Eveningness Questionnaire (MEQ)

The following 19 questions will be about your daily sleep-wake habits and the times of day you prefer certain activities. For each question, please circle or clearly mark the number that corresponds to the answer choice that is most true for you. Please select only ONE answer per question. Base your judgments on how you have felt in recent weeks.

*1.	*Approximately* what time would you get up if you were entirely free to plan your day?	1. 5:00-6:30 a.m. 2. 6:30-7:45 a.m. 3. 7:45-9:45 a.m. 4. 9:45-11:00 a.m. 5. 11:00 a.m.-12:00 noon 6. 12:00 noon-5:00 a.m.
*2.	*Approximately* what time would you go to bed if you were entirely free to plan your evening?	1. 8:00-9:00 p.m. 2. 9:00-10:15 p.m. 3. 10:15 p.m.-12:30 a.m. 4. 12:30-1:45 a.m. 5. 1:45-3:00 a.m. 6. 3:00 a.m.-8:00 p.m.
*3.	If you usually have to get up at a specific time in the morning, how much do you depend on an alarm clock?	1. Not at all 2. Slightly 3. Somewhat 4. Very much
4.	How easy do you find it to get up in the morning (when you are not awakened unexpectedly)?	1. Very difficult 2. Somewhat difficult 3. Fairly easy 4. Very easy
5.	How alert do you feel during the first half hour after you wake up in the morning?	1. Not at all alert 2. Slightly alert 3. Fairly alert 4. Very alert

6.	How hungry do you feel during the first half hour after you wake up?	1. Not at all hungry 2. Slightly hungry 3. Fairly hungry 4. Very hungry
7.	During the first half hour after you wake up in the morning, how do you feel?	1. Very tired 2. Fairly tired 3. Fairly refreshed 4. Very refreshed
*8.	If you had no commitments the next day, what time would you go to bed compared to your usual bedtime?	1. Seldom or never later 2. Less than 1 hour later 3. 1-2 hours later 4. More than 2 hours later
*9.	You have decided to do physical exercise. A friend suggests that you do this for one hour twice a week, and the best time for him is between 7-8 a.m. Bearing in mind nothing but your own internal "clock," how do you think you would perform?	1. Would be in good form 2. Would be in reasonable form 3. Would find it difficult 4. Would find it very difficult
*10.	At *approximately* what time in the evening do you feel tired, and, as a result, in need of sleep?	1. 8-9 p.m. 2. 9-10:15 p.m. 3. 10:15 p.m.-12:45 a.m. 4. 12:45-2:00 a.m. 5. 2-3 a.m.

**11.	You want to be at your peak performance for a test that you know is going to be mentally exhausting and will last two hours. You are entirely free to plan your day. Considering only your internal "clock," which one of the four testing times would you choose?	1. 8-10 a.m. 2. 11 a.m.-1 p.m. 3. 3-5 p.m. 4. 7-9 p.m.
***12.	If you got into bed at 11 p.m., how tired would you be?	1. Not at all tired 2. A little tired 3. Fairly tired 4. 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 are you most likely to do?	1. Will wake up at usual time, but will not fall back asleep 2. Will wake up at usual time and will doze thereafter 3. Will wake up at usual time, but will fall asleep again 4. Will not wake up until later than usual
14.	One night you have to remain awake between 4-6 a.m. in order to carry out a night watch. You have no time commitments the next day. Which one of the alternatives would suit you best?	1. Would not go to bed until the watch was over 2. Would take a nap before and sleep after 3. Would take a good sleep before and nap after 4. Would sleep only before the watch
*15.	You have to do two hours of hard physical work. You are entirely free to plan your day. Considering only your internal "clock," which one of the following times would you choose?	1. 8-10 a.m. 2. 11 a.m.-1 p.m. 3. 3-5 p.m. 4. 7-9 p.m.

16.	You have decided to do physical exercise. A friend suggests that you do this for one hour twice a week. The best time for her is between 10-11 p.m. Bearing in mind only your own internal "clock," how well do think you would perform?	1. Would be in good form 2. Would be in reasonable form 3. Would find it difficult 4. Would find it very difficult
*17.	Suppose you can choose your own work hours. Assume that you work a five-hour day (including breaks), your job is interesting and you are paid based on your performance. At *approximately* what time would you choose to begin?	1. 5 hours starting between 4 a.m. and 8 a.m. 2. 5 hours starting between 8 a.m. and 9 a.m. 3. 5 hours starting between 9 a.m. and 2 p.m. 4. 5 hours starting between 2 p.m. and 5 p.m. 5. 5 hours starting between 5 p.m. and 4 a.m.
*18.	At *approximately* what time of day do you usually feel your best?	1. 5-8 a.m. 2. 8-10 a.m. 3. 10 a.m-5 p.m. 4. 5-10 p.m. 5. 10 pm-5 a.m.
****19.	One hears about "morning types" and "evening types." Which one of these types do you consider yourself to be?	1. Definitely a morning type 2. Rather more a morning type than an evening type 3. Rather more an evening type than a morning type 4. Definitely an evening type

*reverse scoring.
**special scoring: 1. = 6; 2. = 4; 3. = 2; 4. = 0.
***special scoring: 1. = 0; 2. = 2; 3. = 3; 4. = 5.
****special scoring: 1. = 6; 2. = 4; 3. = 2; 4. = 1.

Appendix B

Three Factor Eating Questionnaire-R18 (TFEQ-R18)

The following 18 questions will be about your eating habits. For each question, please circle or clearly mark the number that corresponds to the answer choice that is most true for you. Please select only ONE answer per question. Base your judgments on how you have felt in recent weeks.

1.	When I smell a sizzling steak or juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
2.	I deliberately take small helpings as a means of controlling my weight.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
3.	When I feel anxious, I find myself eating.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
4.	Sometimes when I start eating, I just can't seem to stop.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
5.	Being with someone who is eating often makes me hungry enough to eat also.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
6.	When I feel blue, I often overeat.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True

7.	When I see a real delicacy, I often get so hungry that I have to eat right away.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
8.	I get so hungry that my stomach often seems like a bottomless pit.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
9.	I am always hungry so it is hard for me to stop eating before I finish the food on my plate.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
10.	When I feel lonely, I console myself by eating.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
11.	I consciously hold back at meals in order not to weight gain.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
12.	I do not eat some foods because they make me fat.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True
13.	I am always hungry enough to eat at any time.	1. Definitely False 2. Mostly False 3. Mostly True 4. Definitely True

14.	How often do you feel hungry?	1. Only at meal times 2. Sometimes between meals 3. Often between meals 4. Almost always
15.	How frequently do you avoid "stocking up" on tempting foods?	1. Almost never 2. Seldom 3. Usually 4. Almost Always
16.	How likely are you to consciously eat less than you want?	1. Unlikely 2. Slightly likely 3. Moderately likely 4. Very likely
17.	Do you go on eating binges though you are not hungry?	1. Never 2. Rarely 3. Sometimes 4. At least once a week
*18.	On a scale of 1 to 8, where 1 means no restraint in eating (eating whatever you want, whenever you want it) and 8 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?	1. 2. 3. 4. 5. 6. 7. 8.

*special scoring: 1-2. = 1; 3-4. = 2; 5-6. = 3; 7-8. = 4.

Note: Cognitive restraint scale is composed of items 2, 11, 12, 15, 16, and 18.
Uncontrolled eating scale is composed of items 1, 4, 5, 7, 8, 9, 13, 14, and 17.
Emotional eating scale is composed of items 3, 6, and 10.

Appendix C

Student Adaptation to College Questionnaire (SACQ) Selected Questions

The next 19 statements describe college experiences. For each question, please circle or clearly mark the number that corresponds to the answer choice that is most true for you. Please select only ONE answer per question. Decide how well it applies to you at the present time (within the past few days).

1.	I feel that I fit in well as part of the college environment.
2.	I have been keeping up to date on my academic work.
3.	I am meeting as many people, and making as many friends as I would like at college.
4.	I know why I'm in college and what I want out of it.
5.	I am finding academic work at college difficult.
6.	I am adjusting well to college.
7.	Being on my own and taking responsibility for myself has not been easy.
8.	Lately I have been feeling blue and moody a lot.
9.	I'm not working as hard as I should at my course work.
10.	I have several close social ties at college.
11.	My academic goals and purposes are well defined.
12.	Lonesomeness for home is a source of difficulty for me now.
13.	Getting a college degree is very important to me.
14.	Lately, I have not been using my study time efficiently.
15.	Lately I have been having doubts regarding the value of a college education.
16.	I have some good friends or acquaintances at college with whom I can talk about any problems I may have.
17.	I feel that I have enough social skills to get along well in the college setting.
18.	I haven't been sleeping very well.
19.	I am having difficulty feeling at ease with other people at college.

Appendix D

Stanford Sleepiness Scale (SSS)

This is a quick way to assess how alert you are feeling. Please circle or clearly mark the number that corresponds to how you are feeling right now. Please select only ONE answer.

Degree of Sleepiness	**Scale Rating**
Feeling active, vital, alert, or wide awake	1.
Functioning at high levels, but not at peak; able to concentrate	2.
Awake, but relaxed; responsive but not fully alert	3.
Somewhat foggy, let down	4.
Foggy; losing interest in remaining awake; slowed down	5.
Sleepy, woozy, fighting sleep; prefer to lie down	6.
No longer fighting sleep, sleep onset soon; having dream-like thoughts	7.
Asleep	X

Appendix E
Personal History Questions

Please mark, or write down your answer to each of the following questions.

1.a. Have you seen something similar to any aspect of this assessment before today?

____Yes ____ No

1.b. If so, what aspect? ____

____

____

2. Do you have normal or corrected-to-normal vision right now?

____Yes ____ No

3. Are you a native English speaker?

____Yes ____ No

4. Which hand do you normally write with?

____ Right ____Left ____Both

5.a. To the best of your knowledge, have you consumed any stimulants in the past 24 hours (including, but not limited to: caffeine, energy drinks, amphetamines, nicotine)?

____Yes ____ No ____ Unsure

5.b. If so, how many hours ago?

1. Between 0 – 3 hours ago
2. Between 3 – 12 hours ago
3. Between 12 – 24 hours ago

6.a. To the best of your knowledge, have you consumed any depressants in the past 24 hours (including, but not limited to: alcohol, opiates, benzodiazepines, Xanax)?

____Yes ____ No ____ Unsure

6.b. If so, how many hours ago?

1. Between 0 – 3 hours ago
2. Between 3 – 12 hours ago
3. Between 12 – 24 hours ago

7. Approximately what time did you fall asleep last night? ____________________

8. Approximately what time did you wake up this morning? ____________________

9. Please circle the number that most fits the time frame in which you generally fall asleep. Choose only ONE.

Sleep onset	2:00-3:00 AM 1.	12:45-2:00 AM 2.	10:45 PM-12:45 AM 3.	9:30-10:45 PM 4.	9:00-9:30 PM 5.

10. Please circle the number that most fits the time frame in which you generally wake up. Choose only ONE.

Wake-up	10:00-11:30 AM 1.	8:30-10:00 AM 2.	6:30-8:30 AM 3.	5:00-6:30 AM 4.	4:00-5:00 AM 5.

11. Do you or an immediate family member (siblings, parents, grandparents) have a history of any of the following?

a. Doctor-diagnosed sleep disorders ____Yes ____ No ____ Unsure
b. Irregular sleep patterns ____Yes ____ No ____ Unsure
c. Other sleep complaints ____Yes ____ No ____ Unsure
d. Psychiatric illness ____Yes ____ No ____ Unsure
e. Routine use of prescription medications ____Yes ____ No ____ Unsure
f. Routine use of over-the-counter medications ____Yes ____ No ____ Unsure
g. Recreational drug use (including alcohol) ____Yes ____ No ____ Unsure

Appendix F

Demographic Questions

Please mark or write down your answer to each of the following questions.

1. What is your age? ______________
2. What is your sex?

   _____ Male

   _____ Female

3. What is your year at Emory? ________________
4. What is your major? _________________________________ , ____ Undecided
5. What is your race/ethnicity?

   _____ White/Caucasian

   _____ Black/African American

   _____ East Asian

   _____ South Asian

   _____ Middle Eastern

   _____ Hispanic/Latino

   _____ Native American, American Indian, or Alaskan Native

   _____ Mixed: ____ (please specify)

   _____ Other: ____(please specify)

Appendix G

Emotion Identification Questions

1. **In the first group of photographs, which emotion do you believe was portrayed?**

   ____

2. **In the second group of photographs, which emotion do you believe was portrayed?**

   ____

3. **In the third group of photographs, which emotion do you believe was portrayed?**

   ____

4. **In the fourth group of photographs, which emotion do you believe was portrayed?**

   ____