THE EFFECTS OF EMOTIONAL STATES AND TRAITS ON TIME PERCEPTION

by

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Background: Leading models of time perception share an important element of Scalar Expectancy Theory known as the internal clock, containing specific mechanisms by which the human mind is able to experience time passing and thus to function effectively within society. A major debate exists in the literature about whether to treat factors that influence these internal clock mechanisms (e.g., emotion, personality, executive functions such as inhibition, and related neurophysiological components) as arousal- or attentional-based factors. Purpose: The present study investigated behavioral and neurophysiological responses to an affective Go/NoGo task, taking into account personality correlates related to Behavioral Inhibition and Behavioral Activation Systems, which are major components of Reinforcement Sensitivity Theory. Methods: After completion of self-report inventories assessing personality traits, electroencephalogram (EEG) and behavioral recordings of 32 women and 13 men recruited from introductory psychology classes were made during an affective Go/NoGo task. The task consisted of three phases: 1. A learning phase, during which the participants were exposed to a neutral, visual standard duration ten times. 2. A practice phase, during which the participants practiced responding and inhibiting to “Go” and “NoGo” neutral visual stimuli of varying durations, respectively. For “Go” stimuli, participants' responses were based on their subsequent comparisons of the presented stimuli to the standard via button press (i.e., left button press means "shorter than standard duration", right button press means "longer than standard duration"). 3. A test phase, during which participants responded in the same manner as the practice phase, but "Go" and "NoGo" stimuli were defined according to positive and negative valence. Results: Findings indicated that higher BAS scores (especially BAS Drive) were associated with overestimation bias scores for both negative and positive stimuli presentation, while BIS scores were not significantly correlated with overestimation bias scores. N2 amplitudes were greater in response to "NoGo" stimuli than in response to "Go" stimuli. Furthermore, higher BIS Total scores were associated with higher N2d amplitudes during positive stimulus presentation for 280ms, while higher BAS Total scores were associated with higher N2d amplitudes during negative stimuli presentation for 910ms. BAS Drive scores were consistently and strongly correlated with greater relative left hemisphere asymmetry. Discussion: Findings are discussed in terms of arousal-based models of time perception, and suggestions for future research are considered.

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CHAPTER I: INTRODUCTION

The experience of time passing, however subjective it may be, is a universal aspect of life. The ability to perceive time accurately is often overlooked, yet deficits in time perception play a role in the experience of life for many different clinical populations, including patients with unilateral neglect (Danckert et al., 2007), depression (Hawkins, French, Crawford, & Enzle, 1988; Sevigny, Everett, & Grondin, 2003), attention deficit hyperactivity disorder (ADHD; McGee, Brodeur, Symmons, Andrade, & Fahie, 2004; Meaux & Chelonis, 2005; Smith, Taylor, Brammer, Halari, & Rubia, 2008), Parkinson's disease (Rammsayer & Classen, 1997), and senescence (Rueda & Schmitter-Edgecombe, 2009). In addition, decreases in cognitive functioning and accurate time duration estimation are negatively correlated, which supports the notion that an underlying neurophysiological mechanism for time perception exists and should be further examined and explored beyond theoretical concepts (Coelho et al., 2004; Rakitin, Stern, & Malapani, 2005).

One factor that may influence perception of time is emotion. Emotion is an aspect of life that people experience daily, but is often perceived implicitly as well. Previous research supports the idea that healthy emotional experiences and expression are important for overall well-being (LeDoux, 1995). Research also supports the notion that many neurophysiological regions and chemicals are involved in the perception and expression of emotion. In fact, it has been proposed that emotion is integrated into practically all aspects of cognition (LeDoux, 1995; Megill, 2003).

Personality traits may also have a relationship with time perception, though to date there is little research within this area. One such way to study personality traits, as they pertain to time perception, is through the use of the behavioral inhibition system/ behavioral activation system (BIS/BAS). These systems are thought to have distinct neural pathways, and are typically examined via self-report scales (Carver & White, 1994). The BAS is associated with experiencing positive emotions, like happiness, commonly connected with approach behavior. It is also associated with at least one negative emotion, anger, due to its influence on approach motivation tendencies (Harmon-Jones & Harmon-Jones, 2010). Neurophysiologically, BAS is linked to the mesolimbic dopaminergic pathway (Demaree, Robinson, Everhart, & Youngstrom, 2005). The BIS, on the other hand, is associated with experiencing negative affect, like fear, commonly associated with inhibition. Neurophysiologically, BIS seems to be modulated by adrenergic and serotonergic pathways (Demaree, Robinson, et al., 2005). BIS and BAS strength are associated with right- and left-frontal lobe activation, respectively (Sutton & Davidson, 1997). These findings are generally in line with the valence hypothesis of emotion, which posits that the brain processes emotion in an asymmetric manner according to valence, with the left hemisphere specializing in the experience of positive emotionality and the right hemisphere specializing in negative emotion (Everhart, Carpenter, Carmona, Ethridge, & Demaree, 2003). Some inconsistent baseline asymmetry findings from studies using anger as an emotional factor, which is considered to be negative in valence, led to the consideration of the approach-withdrawal model of emotion. The approach-withdrawal model posits that the left and right frontal lobes are specialized for processing emotions that involve approach and withdrawal behaviors, respectively (Harmon-Jones & Allen, 1998; Harmon-Jones & Sigelman, 2001).

The purpose of this paper is to review research in the areas of time perception, emotion, and the development of the BIS/BAS scales as it relates to relevant clinical populations, and to develop the rationale for experimental study of these individual differences using an affective temporal Go/NoGo ERP task.

CHAPTER II: LITERATURE REVIEW

Time Perception Theory

Time Perception Theory History. One leading theory of human time perception is Scalar Expectancy Theory (also called Scalar Timing Theory), which was first developed by Gibbon in 1977, then elaborated on by the same research team (Gibbon, Church, Meck, & Warren, 1984) via the use of animal models. Scalar Expectancy Theory has been tested using a variety of methods and paradigms, ranging from animal performance on conventional reinforcement schedules (Gibbon, 1977) to the use of temporal reproduction tasks in human clinical populations (Malapani et al., 1998).

Scalar Expectancy Theory utilizes a temporal information processing model, which suggests that a biological internal clock underlies a person's ability to perceive time. This clock is constantly creating neuronal pulses, which are regulated by what theorists call a pacemaker. Once a person's attention is on the passage of time, a "switch" is flipped on and the number of accumulated pulses is counted until a signal is raised when some target interval duration is reached; this number is simultaneously held in reference memory. Subsequent judgments on the passage of time are made by comparing the number of pulses being held in working memory with the value stored in reference memory (Burle & Casini, 2001; Rueda & Schmitter-Edgecombe, 2009; Wearden, 1999).

Previous studies pertaining to how each of the aforementioned devices (i.e., the internal clock, the working-memory store, the reference memory store, and the comparator) work within the model have been completed. The use of external stimuli or internally-activating factors theoretically isolates and alters a device's performance on time perception tasks. It has been thought that the pacemaker's rate can be altered by factors such as body temperature (O'Hanlon, McGrath, & McCauley, 1974) and pharmacological drugs (Meck, 1996), which can be thought of as effects of activation. For example, hypothermia can lead to underestimation and hyperthermia can lead to overestimation, while all drugs that increase cerebral dopamine level are thought to increase pacemaker rate.

Manipulating arousal also influences the pacemaker rate. Initially, Treisman (1963) speculated that an increase in arousal meant an increase in pacemaker rate. Treisman and colleagues (1990) later proposed that the pacemaker frequency is adjusted by a calibration unit that accounts for external stimuli at differing frequencies affecting the pacemaker rate accordingly (Treisman, Faulkner, Naish, & Brogan, 1990). In accordance with this later model, data supported a relationship between increased arousal levels and underestimations of time (Treisman et al., 1990). This finding also suggests that the pacemaker output frequency increased (Penton-Voak, Edwards, Percival, & Wearden, 1996).

Although testing how the pacemaker is accelerated is easily accomplished within the laboratory setting, studies that serve to decrease the pacemaker rate have been problematic from an ethical standpoint until recently. Treisman and colleagues (1990) commented that a drastic decrease in body temperature decelerated participants' internal clocks. Naturally, replicating such studies would pose ethical challenges. In contrast, testing low arousal states using temporal generalization tasks can be used routinely without issue.

A temporal generalization task consists of participants learning a standard duration at the start of the experiment with subsequent comparison stimuli of varying lengths. The participant is asked to judge the comparison stimuli as equal to the standard by indicating “YES” or “NO.” It has been shown that the temporal generalization gradient is usually peaked close to the standard and slightly asymmetrical (Wearden, 1992). Stimuli that are longer than the standard tend to be confused with the standard duration more frequently than shorter stimuli. In a study that included no feedback to participants throughout the temporal generalization task, Wearden and colleagues (1999) observed a reduction in participants’ abilities to discriminate increasingly longer comparison stimuli from the standard duration, suggesting that as arousal was assumed to naturally decrease across the experiment due to boredom, so did the clock’s speed (Wearden, Pilkington, & Carter, 1999).

This phenomenon was also observed in a series of experiments that included the use of a normal temporal generalization task, a verbal estimation task, an episodic temporal generalization task, and a temporal bisection task (Wearden, 2008). These experiments were chosen in order to isolate the pacemaker by comparing performance of the first two experiments mentioned previously to the last two experiments. Performance changed across early and late blocks for the normal temporal generalization and verbal estimation tasks, but not for the episodic temporal generalization or bisection tasks. Slow trial pacing lowered arousal levels for all participants according to self-ratings of arousal taken before and after the experiments. These results indicate that the pacemaker had been slowed down by lowering arousal across the experiments’ durations, and that performance changes for the normal temporal generalization and verbal estimation tasks were not due to decline in attention or motivation. Of course, a shortcoming of this study was that researchers relied on self-report in order to measure participants' arousal levels (Wearden, 2008).

Other models incorporate the concept of "attention" as an important component of time perception. For example, Zakay and Block (1995) added the concept of a "gate" that lies between the pacemaker and the switch that mediates the effects of attention. As more attentional resources are allocated to tracking time, the gate opens wider, allowing more pulses to pass through to the accumulator (Zakay & Block, 1995). It has also been proposed that attentional disruption during a target interval could either stop the accumulation of pulses by opening the switch or by varying the rate of the pacemaker (Casini & Macar, 1997). Time estimation research often involves pairing a secondary task, like reading something aloud, while estimating time in order to prevent participants from counting explicitly, which has been shown to make time estimation much more accurate (Taatgen, van Rijn, & Anderson, 2007). Other studies have included the use of other nontemporal tasks, such as perceptual discrimination, motor activities, and spatial processing (Burle & Casini, 2001). One of the conclusions drawn from this line of research was that time estimation is influenced by the amount of cognitive demand. Specifically, more demanding tasks are associated with shorter time duration estimations.

In order to continue the discussion of attentional processes in time perception, it is important to understand the different types of estimation. There are two types of time estimation: prospective and retrospective. Prospective time estimation involves knowing that an estimate of time will have to be made at the start of a given interval, like those examples previously described. Researchers have referred to prospective time estimation as “experienced duration” since people are likely to have encoded temporal information as one of the most important parts of their experience of the passage of time. Retrospective time estimation on the other hand is an estimation of time after an interval has passed, and is thus commonly referred to as “remembered duration” (Block & Zakay, 1997).

The model of retrospective and prospective time judgments explained by Zakay and Block (1995) is used to show that different processes or systems are employed when estimating time durations either retrospectively or prospectively. This model is especially useful for application to everyday events since it mainly focuses on the duration of time in seconds and minutes, as opposed to milliseconds. The experience of the passing of time for most can be a very complex process, involving both attention and memory resources.

Retrospective time estimation occurs when people experience something for some amount of time, and then are asked to estimate how much time has elapsed. In regards to internal clock models, this could be described as more implicit in nature during the process of experiencing time pass, but more explicit during the actual estimation of the amount of elapsed time. Unfortunately, it is difficult to test because once the participant is asked to estimate duration in retrospect, he or she is more likely to explicitly try to use prospective estimation for any of the following tasks, potentially using different cognitive processes altogether (Zakay & Block, 1995).

A meta-analytic review of 20 experiments comparing prospective and retrospective judgments of duration was conducted to investigate the differences between cognitive processes involved in each. Results indicate that prospective judgments are longer than retrospective judgments, and retrospective judgments are more variable between participants than are prospective judgments. In addition, prospective judgments are shorter when more attention must be given to stimulus information processing, implying that attention plays an important role in prospective time estimation. The finding that retrospective judgments are more variable between subjects suggests that people use different processes to remember their experiences of time. It was also found that attention plays little role in retrospective time estimation (Block & Zackay, 1997).

Findings suggesting that retrospective time estimation utilizes different processes than prospective time estimation are in line with Ornstein's (1970) traditional "storage-size" model of time perception. According to this model, subjective duration is conceptualized as resulting from nontemporal information processing and originates from the quantity and complexity of the information stored in memory. In other words, events that take up more "space" in memory are retrospectively remembered as being longer than those taking up less space; organization of nontemporal information decreases this space. Thomas and Weaver (1975) described a similar model which consisted of a timer that processed temporal information and a stimulus processor that focused on nontemporal information. These two mechanisms were thought to work in parallel and also ascribed to the notion that attentional resources were limited. The resource allocation model of Zakay (1989) also included two processors that work in tandem but have limited capacity as both are competing for short-term memory resources. The resource allocation model explained that during prospective estimations, temporal information gains precedence for processing as compared to nontemporal information; this is different from retrospective estimations, which rely on the “size” of the events that take place being held in short-term memory as they are converted over into long-term memory.

Arousal- Versus Attentional-Based Models. Recently, the attentional gate model was compared to the temporal information processing model in terms of utility and necessity. Block and Zakay (1996) proposed the attentional gate model, which is a combination of Thomas and Weaver’s (1975) previously mentioned model, Treisman’s (1963) internal clock model, and the temporal information processing model; the attentional gate model also included the novel attentional gate described earlier in order to accommodate data from prospective and retrospective timing tasks and for use in both human and animal research (Lejeune, 1998). The attentional gate model adds a gate between the pacemaker and the switch at the level of the clock stage of the temporal information processing model, which is the main difference between it and the temporal information processing model (Lejeune, 1998).

Lejeune (1998) argued that the addition of the gate was unnecessary and redundant because the switch used in the temporal information processing model could account for attentional effects observed in human and animal research, especially if one considers the switch to be a “flickering” switch, or if one takes into account the asymmetrical temporal generalization gradient described earlier. Zakay (2000) countered this conclusion, pointing out the importance of keeping temporal attentional and perceptual-information processes independent of one another within models of prospective time perception, in particular, which a flickering switch model does not do.

It was also argued that the attentional gate model could account for complex temporal patterns with the separation of the gate and switch, while a flickering switch model could only operate in an “all-or-none” fashion (Zakay, 2000). In response to Zakay’s remarks, Lejeune agreed about the independent nature of attention, but also that this was never the issue, nor was it ever stated that the flickering switch incorporated both kinds of information in one unit. Instead, it was argued that the continuity and irregular distribution of attentional processes over time could fit within a flickering switch model (e.g., proportional effects on data versus absolute effects on data for attentional models), and that since attentional processes can influence the switch from outside of the conceptual model, the temporal information processing model should be favored (Lejeune, 2000).

Burle and Casini (2001) followed up on the issues raised by Zakay (2000) and Lejeune (2000) with regard to the mechanism that accounts for attention in time perception. Using a combination of a time production task with a reaction time task, three models of time perception with both activation and attention variables were investigated. They proposed that attention and activation would affect different internal clock mechanisms, specifically the switch and the pacemaker, respectively. The first two models were the attentional gate and the temporal information processing models, while the other model asserted that both attention and activation would affect the pacemaker. Participants were asked to undergo three trials of experiments, starting with a time production task while listening to clicks at varying levels of intensity, followed by a reaction time task, and ending with performing both tasks simultaneously. Participants produced longer durations in the combined task condition than in the time production task only condition, indicating that fewer attentional resources resulted in underestimations of time during the combined task. Furthermore, participants produced shorter durations when click intensity was strong than when it was weak, indicating that activation level increases resulted in overestimations of time durations. Overall, results indicated that attention and activation were indeed independent of one another, and more specifically that activation level affects the pacemaker rate while attention level affects an “all-or-none” functioning switch. These findings lend support to the temporal information processing model (Burle & Casini, 2001).

Time Perception and Emotion

Regardless of model choice, it is clear that time perception is affected by both arousal and attention. Importantly, emotion has been shown to influence both of these variables (Ohman, Lundqvist, & Esteves, 2001; Russell & Mehrabian, 1977). From an arousal perspective, emotional stimuli should lead to overestimations in time perception via a sped up pacemaker rate. Attentional models suggest, on the other hand, that emotional stimuli should distract from temporal information processing, thereby reducing the amount of temporal pulses emitted, resulting in underestimations in time perception. Both of these models have been considered in time perception research using emotional stimuli, and interesting results have been observed.

Past research has clearly indicated that perceived durations of emotionally arousing events are usually distorted according to valence compared to neutral events (Angrilli, Cherubini, Pavese, & Manfredini, 1997; Droit-Volet, Brunot, & Niedenthal, 2004; Effron, Niedenthal, Gil, & Droit-Volet, 2006; Gil, Niedenthal, & Droit-Volet, 2007; Noulhiane, Mella, Samson, Ragot, & Pouthas, 2007; Thayer & Schiff, 1975; Watts &

Sharrock, 1984). Generally, with some exceptions according to experimental design, as arousal increases with the presentation of emotional stimuli, time estimations also increase. Negative valence, but not positive valence, is also generally correlated with overestimations.

The influence of emotional state on the perception of time has been studied among different normal populations. Notably, evidence of a double mechanism comprised of an approach-withdrawal attentional element and an appetitive-aversive emotional element has been supported, and its interaction with two primary components of emotion (affective valence and level of arousal) seems to play a role in evaluation of perceived time (Angrilli et al., 1997). For example, people tended to overestimate negative compared to positive emotional stimuli if the stimuli were highly arousing, while people tended to judge negative emotional low-arousal stimuli as shorter compared to positive low-arousal emotional stimuli during verbal estimation and temporal reproduction tasks. However, no overestimations were observed compared to real time, which Angrilli and colleagues (1997) explained as a function of the complexity of the task used. Angrilli and colleagues further stated that the suprasecond lengths of the stimuli may not have been sensitive enough to detect an arousal effect.

In another study testing the effects of emotion on time estimation, evidence supporting an arousal effect was observed during a temporal bisection task using affective facial stimuli between 400ms and 1600ms (Droit-Volet et al., 2004). An effect of arousal appeared most prominent in that the proportion of “long” responses was higher than “short” responses, and a bias towards long responses was observed. Also of interest was that overestimations varied by stimulus affect. More specifically, faces portraying anger, considered to be a high arousal emotion, were more overestimated than faces portraying sadness, considered to be a low arousal emotion. In fact, as durations of angry facial stimuli increased, participants' overestimations increased as well so much that overestimation was more prominent at longer durations. In terms of internal clock models, emotional stimuli presented at these lengths may be influencing time estimation in a way that results in overestimation via affecting pacemaker speed.

A subsequent study testing the effect of arousal on time perception was conducted using affective facial stimuli, as well, but the role of embodiment was used to explain arousal's effects (Effron et al., 2006). The term "embodiment" refers in this case to imitation of facial expressions as a means of cognitive introspection and perception of emotion in others. It is thought that imitation of emotion of others plays a role in arousal in that enhancement of imitation leads to overestimation. In order to test the role of embodiment on emotion and time perception, a temporal bisection task much like Droit-Volet and colleagues' (2004) previously described study was used. In one condition, participants performed such a task while holding a pen in their mouths while in the other condition participants were free to imitate the facial stimuli that were presented. In line with their hypothesis, participants overestimated emotional stimuli compared to neutral faces only during the free-to-imitate condition (Effron et al., 2006). These results lend support to arousal models of time perception in that replication of Droit-Volet and colleagues' (2004) findings was observed.

In order to assess age-related variations in time perception at an early age, one study was conducted testing 3-, 5-, and 8-year olds using a modified temporal bisection task with angry and neutral stimuli (Gil et al., 2007). It was found that children as young as 3 years of age were able to estimate time, with sensitivity of this skill increasing with age. It was also found that children of all ages in the study judged the angry facial stimuli to be longer than the neutral stimuli durations, again supporting an arousal effect for stimuli of short lengths.

These findings were extended from the visual modality to the auditory modality using affective auditory stimuli in short durations ranging from 2 seconds to 6 seconds in timing reproduction and verbal estimation tasks (Noulhiane et al., 2007). A neutral condition and a self-assessment of valence and arousal were included in order to allow for a better understanding of the effect emotion has on time perception. For the reproduction task, emotional sounds were perceived as being longer than neutral sounds for shorter durations. Furthermore, negative sounds were perceived as longer and more variable than positive sounds for shorter durations. These results are consistent with results from previously explained studies (Droit-Volet et al., 2004; Gil et al., 2007) and support arousal-based models of time perception. During the reproduction task, another interesting finding emerged for the shorter 2-second standard duration condition that was inconsistent with the arousal model. High-arousing stimuli reproduction was shorter than reproduction of low-arousing stimuli. This finding can be explained using attentional models wherein attention should be shared between timing and emotion processing for reproduction tasks, leading to a loss of pulses accumulated. This would result in shorter reproductions for high-arousing stimuli. Similar findings were observed for the verbal estimation task, further corroborating both attentional and arousal modulations of timing emotional events. However, findings from longer durations were inconsistent with past research on arousal. Participants rated sounds equally according to valence and arousal no matter what the valence, even though as durations increased, so should have arousal ratings (Noulhiane et al., 2007). This was explained as a confounding effect of arousal with an attentional effect, which could be indicative of the effects of a “flickering” switch. Results from this study also included main effects of both valence and arousal on duration judgment, whereas past research only produced an interaction between them (Angrilli et al., 1997). This may be explained as a difference resulting from modality choices in tasks, but it remains unclear as to what role modality plays in the context of emotional time perception.

Time Perception and Personality Traits

Using Eysenck’s earlier work on personality (1970), Hogan proposed that variables of personality, specifically extraversion and introversion, could potentially connect the opposing views of temporal perception researchers, among them being Ornstein (1970) with his “storage-size” model described earlier, and Priestly (1968) with an early form of an attention model (Hogan, 1978). Hogan postulated that since, according to Eysenck (1970), extraverts and introverts respond very differently to their physical and social environments, respective perceptions should differ as well. More specifically, extraverts would typically experience a standard amount of stimulation (or level of arousal in terms of current models) as lower compared to the average person, while the opposite would be true of introverts. According to Eysenck’s inhibition theory of extraversion, extraverts have a different reactive inhibition than introverts in that it generates more quickly and dissipates more slowly. Several studies supported the notion that extraverts would overestimate duration compared to introverts (Claridge, 1960; Lynn, 1961). Thus, Hogan included extraversion (a “perception style,” *per se*) and stimulus complexity as dimensional elements in a model of time perception that connected Ornstein's and Priestly's models into a U-function relationship accordingly.

A study testing Hogan's model was performed using a retrospective time comparative design in which participants were asked to observe a standard slide for 30 seconds, and then asked to observe another slide with more or less complexity (Lomranz, 1983). Participants were then asked to compare on a scale of 1 (much less time) to 5 (much more time) the duration of the second slide's presentation to the first slide's presentation. The participants were then asked to complete an inventory assessing extraversion. Hogan's model was supported in that results from this study indicated a U-function relationship between stimulus complexity and duration. More specifically, as complexity increased, duration was perceived as shorter up to a certain level, at which point the opposite was seen in duration perception. The relationship was stronger in extraverts than in introverts, which could point to Eysenck's claim and Hogan's agreement that extraverts have a higher arousal baseline than introverts, such that time perception is not affected in an extravert unless stimulus complexity is extreme (high or low).

More recent research has supported the notion that personality traits affect perception of time. Several studies have shown that extraverts overestimate time relative to introverts (Davidson & House, 1982; Rammsayer, 1997; Zakay, Lomranz, & Kaziniz, 1984); these results were found for low or medium stimulus complexity only, however. On the other hand, several studies have results that show the opposite effect of extraversion on time perception, in that higher extraversion scores were related to underestimation (Buchwald & Blatt, 1974; Wudel, 1979), and other studies find no effect of extraversion on time estimation (Gray, Gray, & Loehlin, 1975; Kirkcaldy, 1984).

Others have offered various theories concerning personality traits and the resultant effects on behavior. According to Gray (1990), cognition and emotion are two distinct variables to be thought of within models, but he argues that perhaps this distinction should not be made. Instead, these two variables should be thought of as a function of reinforcement behaviors that help people adapt and shape personality. Gray's reinforcement sensitivity theory is comprised of three fundamental emotion systems: the Behavioral Activation System, the Fight-Flight-or-Freeze System, and the Behavioral Inhibition System. Each system is associated with neural activity and neurotransmitters, including dopamine, which is of particular interest in time perception research as it plays an important role in motor movement timing.

Dopamine is also associated with feelings of pleasure and is used by the brain to reinforce behaviors associated with seeking out certain pleasurable experiences. Dopamine is thought to play a central role in the motivation system called BAS, which is sensitive to indications of reward, nonpunishment, and escape from punishment, causing a person to engage in goal-oriented behavior (Carver & White, 1994). According to Gray's Reinforcement Sensitivity Theory, BAS is also thought to be responsible for the experience of positive emotions (Balconi , Falbo, & Brambilla, 2009; Carver & White, 1994). In an electrophysiological study using positive, negative, and neutral emotional stimuli, people who rated high on the BAS scale had a significant and more intense response to positive emotional stimuli than to negative or neutral stimuli (Balconi et al., 2009). It has been found that people who have high BAS scores have increased left-frontal activation (Coan & Allen, 2003), especially when presented with positive emotional stimuli (Balconi et al., 2009). These findings are in line with Gray's theory. Gray's theory is also supported on the molecular genetics level as high dopamine activity indicated through the investigation of COMTxDRD2 epistasis was associated with high BAS scores (Reuter, Schmitz, Corr, & Hennig, 2006).

Another component of Gray's theory is the BIS, which is associated with anxiety, and is sensitive to signals of punishment, nonreward, and novelty (Carver & White, 1994). It has been found that people who score high on BIS have greater right-frontal activation in EEG studies (Balconi et al., 2009; Demaree, Robinson, et al., 2005; Demaree, Everhart, Youngstrom, & Harrison, 2005). People who score high on BIS are thought to experience more negative affect than those people who score low on BIS.

In relation to time perception, little research has been completed with regards to personality traits, specifically according to Gray's theory. However, negative affect is correlated with BIS. In one study, individual differences in negative emotionality were found to influence time perception during the experience of negative emotion. The presentation of angry and fearful facial stimuli was correlated with increased levels of overestimation (Tipples, 2008). This finding supported arousal-based models of time perception. One explanation offered as to why an attentional effect was not observed (i.e., one that would have resulted in underestimations of angry and fearful stimuli) is that the attentional effects were mediated by emotional arousal through noradrenaline increase thought to originate in the locus coeruleus, which affects the operation of both attentional and time processes, and is also thought to facilitate orienting and slower disengagement of attention (Tipples, 2008). Of particular interest was the finding that angry faces led to greater overestimations of time durations than both fearful and happy expressions (Tipples, 2008). This was unexpected since fearful faces are usually judged as appearing more aroused than angry faces, meaning that fearful facial stimuli should have led to similar overestimations as angry faces. This finding may be indicative of the presence of an anger-specific response system, and may be linked to Gray's reinforcement sensitivity theory.

Time Perception and Clinical Populations

Another reason prospective time estimation studies have been employed is because they can provide great insight into the cognitive processes involved in many clinical populations that have difficulties in executive functioning due to neurophysiological or neurochemical abnormalities. Prospective time perception tasks have been utilized to observe deficits in cognitive functioning among people with unilateral neglect, ADHD, aging, mood disorders like depression, and motor movement disorders like Parkinson's disease.

In a study of unilateral neglect patients, it was found that people with unilateral right-hemisphere neglect have a difficult time estimating multisecond durations of time as they significantly underestimated all durations tested against controls (Danckert et al., 2007). This study also pointed to the importance of the fronto-parietal network of the right hemisphere in the perception of time.

Another study involving ADHD adolescents produced results that stressed the importance of similar brain regions and neural networks in time estimation, specifically noting the right lateral prefrontal cortex and anterior cingulate gyrus and how abnormalities in this region in adolescents with ADHD were associated with decreased activation in these areas compared to controls (Smith et al., 2008). Results from another study involving children suffering with ADHD along with children with a reading disorder indicated that children with ADHD overestimated the time taken to fill out Conners' Continuous Performance Test compared to children with a reading disorder, but both groups performed comparably on an explicit time estimation task, stressing the importance of both affective state and attention in time perception (McGee et al., 2004). Findings from a study involving boys and girls with ADHD suggested that behavioral inhibition is an important component of time perception, in that less behavioral inhibition was associated with poor time perception (Meaux & Chelonis, 2005). As inhibition has much to do with the dopaminergic-reward system, findings from a study involving adults with ADHD indicated that this population contracts interval durations, suggesting the significance of impaired dopamine dynamics in the ADHD population (Gilden & Marusich, 2009).

Aging is associated with less accurate time perception as a function of frontal lobe changes associated with healthy aging (Gunstad, Cohen, Paul, Luyster, & Gordon, 2006). Another study comparing young adults, older adults, and patients with Alzheimer's disease confirmed the notion that variability in time perception increases with age, and also found that variability increases even more dramatically with the onset of Alzheimer's disease (Rueda & Schmitter-Edgecombe, 2009).

Mood disorders, specifically depression, have been found to affect many cognitive functions, including the perception of time. One study comparing depressed and nondepressed participants on the Continuous Performance Test demonstrated that depressed patients had a difficult time discriminating between relatively long durations compared to nondepressed participants (Sevigny et al., 2003). Findings from another study involving depressed patients revealed that depression seems to elongate the experience of time passing; however, chronometric time judgments were not affected with time duration estimations in minutes (Hawkins et al., 1988).

Another clinical population that has been shown to have problems with time estimation is the Parkinson's disease population. The Parkinson's disease population is of particular interest in time perception research because it has long been thought to be a disorder of the basal ganglia, associated with the degeneration of neurons in the pars compacta in the substantia nigra, which is part of the previously mentioned dopaminergic-reward pathway (Rammsayer & Classen, 1997). The subsequent depletion of dopamine in the dorsal striatum affects movement abilities, resulting in the classic motor movement symptoms of Parkinson's disease of tremor, rigidity, bradykinesia, and postural instability. This is of particular interest for time perception research because it has been suggested that the same timing mechanism involved in duration estimation and information processing is used in timing behavior, including motor movements (Treisman, Faulkner, & Naish, 1992).

To investigate this relationship, one study tested 20 patients with Parkinson's disease against matched controls in a temporal discrimination task of durations in milliseconds. The Parkinson's disease group performed significantly poorer than the control group, in that the Parkinson's disease group could discriminate durations from one another as long as they were around at least 90 milliseconds different from each other, compared to the control group having a threshold around 20 milliseconds (Rammsayer & Classen, 1997). While results indicated that Parkinson's disease patients have a difficult time discriminating durations of short time intervals from each other compared to controls, results correlating the severity of motor movement symptoms of the Parkinson's disease group revealed nonsignificant findings. This is contrary to the notion that the same timing mechanism is shared by both duration estimation and motor movement timing.

Another time estimation study of short auditory durations in Parkinson's disease patients and age- and IQ-matched controls involving the use of a click manipulation had findings that seemed to contradict this relationship, as the Parkinson's disease group had results that were comparable to the control group (Wearden et al., 2009). As both of the previously-mentioned studies involved participants in the Parkinson's disease group who were currently taking dopaminergic medication, it is important to consider the effects of this factor on the possibility of there being a relationship between motor movement symptomatology and time estimation performance. The Wearden and colleagues (2009) study included participants in the Parkinson's disease group in both "on" and "off" states in regards to taking medication, and results indicated no significant difference in performance across conditions. Rammsayer and Classen (1997) suggest that performance on temporal perception with regards to medicated patients with Parkinson's disease should be thought more of as a trait marker for dopamine decreases in the basal ganglia as opposed to an acute indicator of clinical symptomatology.

Another study testing the effect of Parkinson's disease on temporal perception across different modalities and durations was conducted (Smith, Harper, Gittings, & Abernethy, 2007). Patients with Parkinson's disease participated in a duration-bisection task across both auditory and visual modalities and across both sub- and supra-second intervals. Results indicated impairment in temporal perception in the longer duration for the Parkinson's disease group. Researchers from this study suggest that the bisection procedure utilized in this study may be useful to test further the role of the basal ganglia in temporal perception.

Electrophysiology, Time Perception, and Inhibition

One way to gain insight into any cognitive or emotional (if indeed you can separate the two) event that occurs at the subsecond level is to examine event-related potentials, or ERPs. ERPs are voltage changes that occur as a result of the brain's response to a presented stimulus, and are thought to represent post-synaptic changes in neurons (Coles & Rugg, 1995). ERPs are recorded from a participant via electrodes evenly distributed across the scalp while the participant engages in an experimental task. Positive and negative deflections of voltage (e.g., N1, P1, N2, P2, etc.) are of particular interest in cognitive neuroscience research, as are the latencies in milliseconds and amplitudes in microvolts of these deflections. Recent research in time perception has used EEG to investigate neural correlates of temporal events.

One such study incorporated a temporal generalization task at the subsecond level using emotional and neutral facial stimuli (Gan, Wang, Zhang, Li, & Luo, 2009). Under the emotional conditions, the P160 and P280 amplitudes were enhanced and the N230 amplitude was decreased, suggesting that emotion modulated temporal processing even at the subsecond level. A surprising finding from this study was that the smallest N2 amplitudes, thought to be indicative of inhibition, were recorded for angry facial stimuli. This task was an implicit emotional task, however, and so an attentional bias in processing could account for these findings.

Chen and Yeh (2009) were interested in the effects of adding a sound or visual object to the judgment of visual or auditory duration, respectively. They used an oddball paradigm to do this, which consisted of the presentation of a series of standards and "oddballs" to participants according to modality. For example, one experiment in this study consisted of standards that were auditory sounds while the oddballs were visual objects. Participants were asked to compare the presented duration of an oddball to the duration of the standards. Results indicated asymmetric cross-modal effects, more specifically that sound seemed to extend a perceived visual duration while visual object presentation had no effect on auditory time estimation (Chen & Yeh, 2009).

An aspect of executive function that is important in timing in conversations and withholding inappropriate responses is inhibition. Inhibition has been studied electrophysiologically using a Go/Nogo ERP task. In this type of task, participants are presented with target and nontarget stimuli and are asked to refrain from responding after the presentation of nontarget stimuli. Two ERP components are usually of interest in this kind of study, namely the N2 and P3 (Falkenstein, Hoormann, Hohnsbein, 2002; Beste, Dziobek, Hielscher, Willemssen, & Falkenstien, 2009).

The N2 is a frontal negative displacement that usually occurs between 200ms and 300ms after stimulus presentation. The P3 is a fronto-central positive displacement that usually occurs between 300ms and 500ms after stimulus presentation. The N2 component is thought to reflect inhibition on a premotor level (Falkenstein, Hoorman, & Hohnsbein, 1999), while the P3 component is thought to reflect motor inhibition, or the evaluation of inhibitory processes (Beste et al., 2008; Burle et al., 2004). A right preponderance of activity has been recorded on occasion for both the N2 and P3 (Falkenstein et al., 2002). Orbitofrontal and inferior anterior cingulate cortices (ACC) are thought to mediate the generation of these ERP components (Beste et al., 2009; Yu, Yuan, & Luo, 2009).

Yu and colleagues (2009) used an auditory Go/Nogo ERP task in order to investigate the effects of auditory emotion on response inhibition. Results indicated that response times were longer for “go” stimuli for negative compared to positive and neutral conditions. Interestingly, the “nogo” N2 was larger for neutral conditions than for the emotion conditions. This suggests that emotional sounds have a modulatory effect on behavioral inhibitory performance (Yu et al., 2009).

Hypotheses

There has been much research in the areas of time perception, emotion, and personality. To date, however, the relationships among these variables and the neural correlates have not been systematically examined. The present study utilized a Go/Nogo time perception task using emotional stimuli to test the effect of emotional valence on time perception. Self-reported personality characteristics using the BIS/BAS scales and inhibitory neural correlates derived from ERPs were also examined. The purpose of the present study was to:

(1) Examine the relationship among levels of BIS/BAS, affect, and perceived stimulus duration using behavioral and self report measures. Since visual emotional stimuli elicit higher arousal levels, it was hypothesized that participants would overestimate durations of emotional stimuli compared to neutral stimuli. More

specifically, higher self-reported BAS scores would be associated with the tendency to overestimate the amount of time that positive stimuli were presented since previous findings indicated higher BAS scorers had more intense responses to positive stimuli (Balconi et al., 2009). Furthermore, self-reported BIS scores would be associated with the tendency to overestimate the amount of time that negative stimuli were presented.

(2) Use the Go/Nogo paradigm to compare the effects that BIS/BAS, stimulus duration and stimulus valence have on the inhibitory N2 component. It was hypothesized that N2 amplitudes during Nogo stimuli would be larger than those observed during Go stimuli. The N2 component was also expected to be different for participants who scored higher on BAS compared to participants who scored higher on BIS. With regard to stimulus valence, higher scores on BAS would be associated with larger N2 amplitudes for positive Nogo stimuli, while higher scores on BIS would be associated with larger N2 amplitudes for negative Nogo stimuli.

(3) Replicate findings from past research regarding resting asymmetry and the BIS/BAS measures. It was hypothesized that high scores on BIS would be associated with right frontal activity while high scores on BAS would be associated with left frontal activity.

CHAPTER III: METHOD

Participants

Based on a priori power analysis to detect large effects with 80% power using GPower 3.1, forty-five right-handed volunteers aged 18 years and older (*M* = 19.78, *SD* = 4.1) from East Carolina University were recruited using the undergraduate psychology participant pool. Of these participants, 32 were women and 13 were men. All participants had normal or corrected-to-normal vision and no prior significant neurological or psychiatric history.

Materials

Participants completed several self-report measures before the experimental procedure. Carver and White's (1994) BIS/BAS scales were completed by the participants as a way to measure behavioral inhibition and behavioral activation of each participant, and the Lateral Preference Inventory was administered to assess for handedness and other features of lateral preference (i.e., eye, ear, leg) (Coren, Proac, & Duncan, 1979). Other self-report measures that were administered include the Barratt Impulsiveness Scale, the Mini IPIP Scales, and the Sensation-Seeking Scale.

The Barratt Impulsiveness Scale is a reliable measure of impulsivity with three factors (nonplanning, motor impulsivity, and attention impulsivity) in both normal and clinical populations (Spinella, 2007). The Mini-IPIP is a short form of the 50-item International Personality Item Pool- Five-Factor Model measure that is used to survey the Big Five personality traits; it has demonstrated consistent convergent, discriminant, and criterion-related validity (Donnellan, Oswald, Baird, & Lucas, 2006). The Sensation

Seeking Scale has demonstrated satisfactory internal reliability when total scores are considered, but when the subscales (Thrill and Adventure-Seeking, Experience Seeking, Disinhibition and Boredom Susceptibility) are considered separately, some concern is raised with regards to each of their reliabilities, especially considering its use of dated language and examples of sensation-seeking activities (Gilchrist, Povey, Dickinson, & Povey, 1995).

Equipment and Stimuli

The control and presentation of the experimental stimuli and recording of participants responses were managed with SCAN 4.4 software (Compumedics Neuroscan, El Paso, TX). The stimuli that were presented to represent duration conditions consisted of three types of pictures (positive, negative, or neutral) selected from the IAPS, which were matched for valence and arousal (Bradley & Lang, 2007). All items were matched for luminance and size. Event related potentials were recorded during stimuli presentation throughout the duration of the task.

Affective Go/NoGo Task

Participants performed a temporal Go/Nogo task using emotional stimuli, adapted from two primary studies (Falkenstein et al., 2002; Gan et al., 2009). It was comprised of a learning phase, a practice phase, and a testing phase. During the learning phase, participants were shown the “standard” stimulus duration (700 ms) 10 times, represented by a gray oval on the screen that was the same size as the actual stimuli (Figure 1).

During the practice phase, participants learned the Go/Nogo paradigm using neutral stimuli for both target and nontarget stimuli. The target stimuli were neutral IAPS pictures while the nontarget stimulus was the gray oval used during the learning

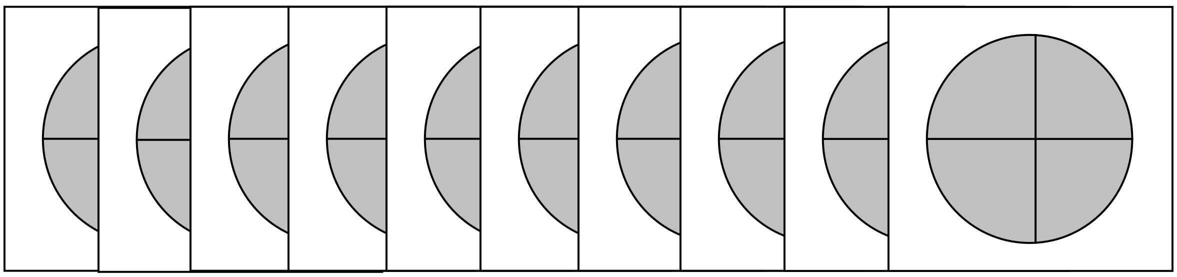
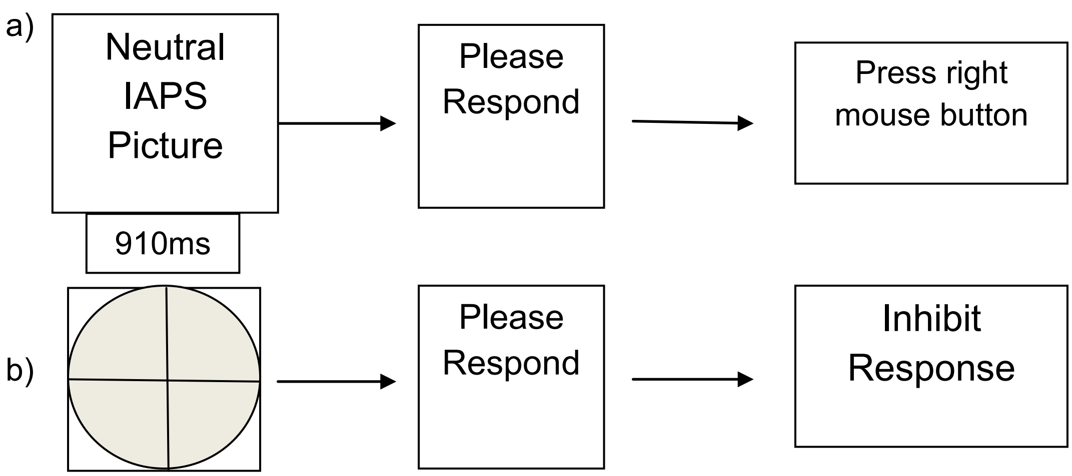


Figure 1. Learning phase: “Standard” stimulus (700ms) was presented 10 times in succession represented by a shape.

phase. In its entirety, the practice phase consisted of one trial block with 150 presentations of target stimuli (30 presentations of each duration condition) and 50 presentations of nontarget stimuli; however, participants were only exposed to 7 minutes of the practice phase in order to allow enough time for them to gain mastery of the task without becoming bored or lethargic. Stimuli were presented in five stimulus durations (280ms, 490ms, 700ms, 910ms, and 1120ms). The occurrence of target and nontarget stimuli was pseudo-random, and the interstimulus interval was 1600ms. The participants compared the duration of the target stimulus presentation to the “standard” duration. The participants then responded using a mouse according to the comparison made. If the participants made the judgment that the target stimulus duration was longer than the “standard” duration, the participants were instructed to press the right mouse button using the third finger of the right hand. If the target stimulus was perceived as being shorter than the “standard” duration, the participant was instructed to press the left mouse button using the index finger of the right hand. Even though some target stimuli were equal in duration to the “standard” stimulus duration, participants were forced to choose between only two responses (longer than or shorter than the “standard”). This allowed for testing the effect that personality traits and/or emotion had on time estimation (Figure 2).

Figure 2. Practice phase

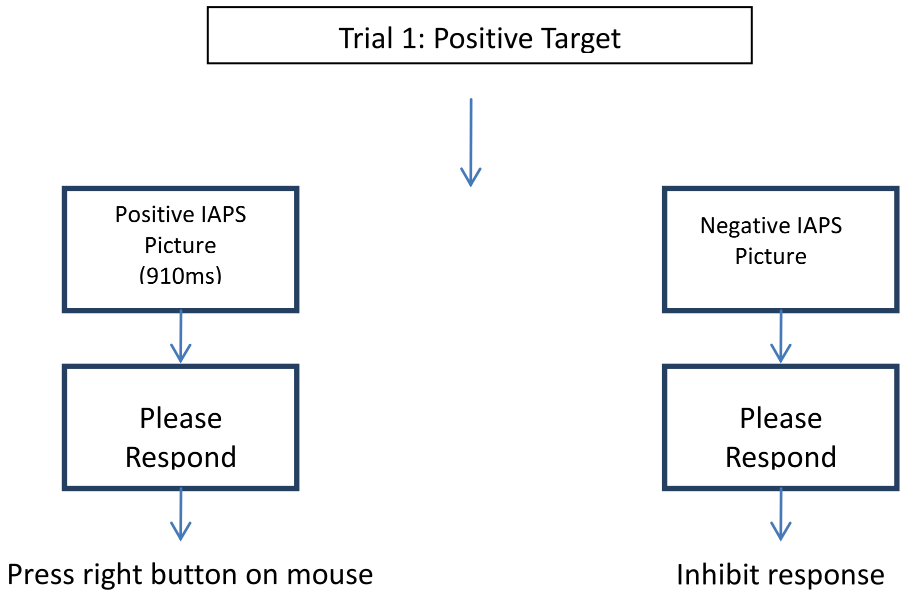


(a) If the participant is presented with the target stimulus (in the example above, the target stimulus is a neutral IAPS picture), the participant will judge if the stimulus is shorter or longer than the standard duration. In the example above, the participant should press the right button on the mouse to indicate that the duration was longer than the standard stimulus duration.
(b) If the participant is presented with the nontarget stimulus (the gray oval used in the learning phase), the participant will inhibit any response and wait for the next stimulus presentation.

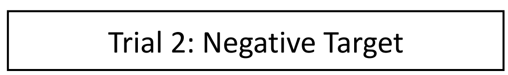
During the testing phase, participants encountered two trials of the previously described Go/Nogo task, in which target stimuli were based on valence (positive or negative). During one trial block, positive IAPS pictures served as target stimuli with negative IAPS pictures acting as the nontarget stimuli. During this trial block, participants chose if a positive stimulus was shorter than or longer than the "standard" duration, and inhibited any response to negative stimuli (Figure 3a). During the other trial block, negative IAPS pictures were the target stimuli while positive IAPS pictures were nontarget stimuli. Participants chose if a negative stimulus was shorter than or longer than the "standard" duration during this trial block, and inhibited any response to positive stimuli presentation (Figure 3b). The order of the positive and negative target sessions was counterbalanced across participants. The target stimuli were presented 150 times while nontarget stimuli were presented 50 times. The occurrence of target and nontarget stimuli within each block was pseudo-random, and the interstimulus interval was 1600ms. Each block contained 200 trials. The duration conditions were the same as those explained in the practice phase, and participants only had two possible response choices for target stimuli (longer than or shorter than the "standard"). Participants were encouraged to respond as quickly as possible to target stimuli through written and verbal instructions prior to task completion. Participants were presented with the "standard" duration five times between blocks.

Figure 3. Test phase.

a)



b)



a) During the Positive Target Trial Block, if the participant is presented with a target stimulus (positive IAPS picture), the participant will compare its duration to the "standard" duration. The participant will then respond using the mouse as was learned during the practice phase. In the example above, the participant should judge the duration to be longer than the "standard," and thus press the right button on the mouse. When presented with a negative (nontarget) stimulus, the participant should inhibit a response.

b) During the Negative Target Trial Block, if the participant is presented with a target stimulus (negative IAPS picture), the participant will compare its duration to the "standard" duration, and then respond using the mouse. In the example above, the participant is presented with a "shorter" stimulus, and thus should respond by pressing the left button on the mouse. When presented with a positive (nontarget) stimulus, the participant should inhibit a response.

Procedures

Participants were tested in the Cognitive Neuroscience Laboratory located within the Department of Psychology at East Carolina University. Prior to participation, informed consent forms that were approved by the University Policy and Review Committee on Human Research of East Carolina University were reviewed orally with each participant and signed by each participant. Adherence to the "Ethical Principles of Psychologists and Code of Conduct" was kept with all participants in this study (American Psychological Association, 2002). Once consent was established, participants completed self-report inventories and were acclimated to EEG recording procedures and given written instructions for the Affective Go/NoGo Task.

Procedures for electroencephalogram (EEG) analysis were adapted from Everhart and Demaree (2003). Participants were seated in an electrically shielded room in a comfortable reclining chair and fitted with a lycra electrode cap (Electro-Cap International, Inc.). Electrodes were arranged according to the 10-20 international system (Jasper, 1958). EEG data were recorded from 32 active electrode sites using linked ears (A1 and A2) as a reference (monopolar montage). Electrode placement included Frontal: F3, F4, F7, F8; Central: Cz, C3, C4; Temporal: T3, T4, T5, T6; Parietal: Pz, P3, P4; and Occipital: O1, O2. In addition, electrodes were placed on the outer cantus of each eye so that eye movement recordings could be obtained. Electrode impedance was maintained below 5000 holms and checked at the beginning and end of the experimental session. Eye movement recordings were used to correct for the presence of eye movement artifact in the ERPs and to determine which trials should be excluded from averaging. Individual trials that contained excessive artifact associated with body and eye movement were excluded during off-line processing and prior to averaging. The EEG and eye movements were recorded with a bandpass of 1 and 100 Hz and a sensitivity of 7.5 μV/mm for EEG recordings. The EEG signal was amplified and converted on line to digital using a NeuroScan 32-channel PC based EEG/Evoked potential brain mapping system. A high-pass filter was used to eliminate slow wave frequencies that were less than 2 Hz. A 60 Hz notch filter was used to eliminate 60 Hz line noise. Artifact reduction was completed prior to computing grand averages for EEG and N2 data. Data were stored and analyzed on a PC Pentium Computer. The EEG data were converted on line for display, storage, and analysis (Everhart & Demaree, 2003).

Once participants finished reading through the instructions for completing all experimental procedures, baseline EEG was recorded according to procedures adapted from Davidson (1988), including four minutes of baseline recording alternating between eyes open and eyes closed conditions. Participants then participated in the learning, practice, and test phases of the affective Go/NoGo task. Before each trial of the test phase, participants engaged in the learning phase. Error rate was measured as a behavioral variable to assess a bias in time perception during the “Go” standard duration stimuli presentations. After completion of all trials, the N2 responses were identified by visual inspection as the most negative peak between 100ms and 300ms (Falkenstein et al., 2002). Difference waves between Go and NoGo stimuli of equal duration for each valence were computed to form the N2d component (Nogo-Go). Separate grand averages for all data were created. Event related potentials were averaged across participants for emotional valence and stimulus duration.

Analyses

Hypothesis One. Correlational analyses were performed to determine the relationship between BIS, BAS, and an overestimation bias score when presented with target stimuli that were equivalent to the “standard” duration. The overestimation bias score was computed as the proportion of “longer” responses to the overall number of responses made during each test phase trial. The distribution of these scores was roughly normal. These analyses were used to investigate the hypothesis that higher self-reported BIS scores would be associated with the tendency to overestimate the amount of time that negative stimuli were presented. These analyses were also used to investigate the hypothesis that higher self-reported BAS scores would be associated with the tendency to overestimate the amount of time that positive stimuli were presented.

Hypothesis Two. Paired samples t-test was used to investigate the hypothesis that N2 amplitudes for “NoGo” stimuli would be larger than N2 amplitudes for “Go” stimuli. ANCOVA with BIS/BAS as covariates and the dependent variable of N2d amplitude (NoGo-Go N2 amplitude for emotion and duration condition) was also conducted. Duration (short and long) and valence (positive and negative) were included as factors. These analyses were used to investigate the hypothesis that higher BAS scores are associated with greater N2 amplitudes for positive Nogo stimuli. These analyses were also used to investigate the hypothesis that higher BIS scores are associated with greater N2 amplitudes for negative Nogo stimuli.

Hypothesis Three. In order to investigate the hypothesis that high scores on BIS are associated with right frontal activity while high scores on BAS are associated with left frontal activity, an asymmetry score (R-L) for alpha power (8-12 Hz) was calculated. Correlational analyses for BIS and BAS scores with the asymmetry score were then conducted.

CHAPTER IV: RESULTS

Statistical analyses were conducted using SPSS 19 statistical software package (IBM, Inc., Armonk, NY). Raw data were initially inspected for missing data and normality. Behavioral data from seven participants were incomplete due to noncompliance with the task, and were left out of correlational analyses for hypothesis one. Due to substantial electrooculography (EOG) and electromyography (EMG) artifact during ERP recordings, nineteen participants were excluded from ANCOVA for hypothesis two. EOG and EMG were related to researchers' observations of participants shifting in their seat and a considerable amount of yawning behaviors. Due to artifact during resting asymmetry recording, four participants were excluded from correlational analyses for hypothesis three.

Hypothesis One: Relationships Between BIS, BAS, and Time Perception

Results for evaluation of assumptions of normality indicated a positively skewed leptokurtic distribution of BAS Reward Responsiveness, which was corrected by excluding two univariate outliers on BAS Reward Responsiveness from analysis. This and initial exclusions due to noncompliance with task resulted in a total sample n of 36 participants for correlation analysis. Power analysis indicated that this sample size would yield power of 56% for a medium-sized effect ($\rho = .3$).

In order to determine the relationship between BIS, BAS, and overestimation tendencies according to stimulus valence, directional correlation analyses were performed. Basic descriptive statistics and zero-order correlation coefficients between BIS, BAS subscales, and overestimation bias scores are presented in Table 1. Self-reported BAS Total (BAS TOT) scores (*M* = 21.91, *SD* = 5.13) were significantly, positively correlated with overestimation bias scores (OEPos) for positive stimuli (*M* = 49.35, *SD* = 24.70), *r* = .292, *n* = 36, *p* = .0421, 90% CI [0.014, 0.53]. Self-reported BAS Drive (BAS D) scores (*M* = 10.07, *SD* = 3.22) were significantly, positively correlated with OEPos (*M* = 49.35, *SD* = 24.70), *r* = .312, *n* = 36, *p* = .0320, 90% CI [0.036, 0.54]. These findings support the hypothesis that higher BAS scores would be associated with the tendency to overestimate positive “Go” stimuli. On the other hand, self-reported BIS scores (*M* = 15.42, *SD* = 3.73) were not significantly correlated with overestimation bias scores (OENeg) for negative stimuli (*M* = 53.068, *SD* = 27.49), *r* = .056, *n* = 36, *p* = .373, 95% CI [-0.277, 0.377]. There was insufficient evidence to support the hypothesis that higher BIS scores would be associated with the tendency to overestimate negative “Go” stimuli.

Significant correlations were found between BAS TOT and all BAS subscales, BAS RR (*r* = .440, *n* = 36, *p* = .004), BAS D (*r* = .874, *n* = 36, *p* < .001), and BAS FS (*r* = .811, *n* = 36, *p* < .001). Other significant positive correlations were found between BAS subscales, BAS D and BAS Fun-Seeking (BAS FS) (*r* = .464, *n* = 36, *p* = .002), as well as BAS RR and BAS FS (*r* = .325, *n* = 36, *p* = .027). A significant positive correlation was also found between behavioral overestimation bias scores, OEPos and OENeg (*r* = .574, *n* = 36, *p* < .001).

Table 1.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and overestimation bias scores.

		OEPos	OENeg	BIS	BAS			
					TOT	RR	D	FS
BAS	FS							
	D							.464**
	RR						.187	.325*
	TOT					.440**	.874**	.811**
BIS					-.019	.171	-.131	.073
OENeg				.056	.212	.110	.262	.063
OEPos			.574**	.155	.292*	.025	.312*	.186
Mean		49.352	53.068	15.420	21.910	4.580	10.070	7.260
SD		24.696	27.487	3.730	5.131	0.879	3.217	2.381

$^{*}p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, OEPos = Overestimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

In order to further investigate the relationship between BIS, BAS, and overestimation tendencies according to stimulus valence, correlation analyses were performed after stratifying data by sex. This was done in response to observations that women tended to have higher positive overestimation bias scores (*M* = 50.557, *SD* = 28.568) compared to men (*M* = 43.936, *SD* = 12.462), as well as higher negative overestimation bias scores (*M* = 54.783, *SD* = 28.677) compared to men (*M* = 47.943, *SD* = 23.813). There were also far fewer men than women who participated in this study, and most of the men participated over the summer as a way to earn extra credit in class, making their motivation for participating in this study different than that of those who participated over the fall semester for course credit. It was also observed that many of the men participating in this study were athletes who underwent the experiment after enduring athletic conditioning practices over the summer, causing fatigue and questionable motivation to complete the task. Basic descriptive statistics and zero-order correlation coefficients between BIS, BAS subscales, and overestimation bias scores for women are presented in Table 2. Self-reported BAS D scores (*M* = 11.000, *SD* = 3.142) were significantly, positively correlated with OEPos (*M* = 50.557, *SD* = 28.568), *r* = .345, *n* = 28, *p* = .0360, 90% CI [0.073, 0.57]. This finding supports the hypothesis that higher BAS scores would be associated with the tendency to overestimate positive “Go” stimuli. No other significant correlations were found. There was insufficient evidence to support the hypothesis that higher BIS scores would be associated with the tendency to overestimate negative “Go” stimuli.

Table 3 presents correlational data between men's self-reported BIS and BAS scores and overestimation bias scores. No significant correlations were found, indicating insufficient evidence to support hypothesis one.

Table 2.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and overestimation bias scores for women.

		OEPos	OENeg	BIS	BAS			
					TOT	RR	D	FS
BAS	FS							
	D							.583**
	RR						.125	.446**
	TOT					.605**	.808**	.877**
BIS					.473**	.494**	.346*	.281
OENeg				.206	.189	-.018	.275	.126
OEPos			.609**	.277	.258	-.077	.345*	.254
Mean		50.557	54.783	14.630	23.410	5.000	11.000	7.410
SD		28.568	28.677	4.030	6.026	2.140	3.142	2.500

**p* < .05; ***p* < .01

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, OEPos = Overestimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 3.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and overestimation bias scores for men.

		OEPos	OENeg	BIS	BAS			
					TOT	RR	D	FS
BAS	FS							
	D							.431
	RR						.543*	.468
	TOT					.712**	.838**	.834**
BIS					-.285	-.103	-.562*	.038
OENeg				-.121	.269	.497	.299	.016
OEPos			.560*	-.031	.163	.203	.333	-.092
Mean		43.9356	47.943	18.310	20.230	4.770	8.000	7.460
SD		12.462	23.813	2.689	4.885	0.927	2.483	2.570

*$p < .05$; **$p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, OEPos = Overestimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Hypothesis Two: Personality, Affective States, and the N2

In order to investigate the hypothesis that N2 amplitudes would be greater (more negative) in response to “NoGo” than to “Go” stimuli presentations, directional paired samples t-test was performed. Due to artifact, eight participants were excluded from this analysis, leaving *n* of 37. Power analysis indicated that this sample size would yield power of 57% for a medium-sized effect (ρ = .3). As expected, N2 amplitudes were significantly greater (more negative) in response to “NoGo” stimuli (*M* = -7.136 microvolts, *SD* =4.0364) than in response to “Go” stimuli (*M* = -6.118 microvolts, *SD* = 3.379), $t(36) = 1.886$, $p = 0.0335$, 90% CI [0.106, 1.929]. This finding supports the hypothesis that “NoGo” N2 amplitudes would be more negative than “Go” N2 amplitudes.

N2d difference waves were calculated in order to serve as the dependent variable in analyses of covariance across Go and NoGo conditions. Go and NoGo Grand averages for N2 amplitudes for positive and negative conditions are presented in Figures 4 and 6, respectively. Grand averages for N2d waves for positive and negative conditions are presented in Figures 5 and 7, respectively. GLM ANCOVAs were conducted to evaluate the influence of emotional valence (positive or negative) and duration (280ms, 490ms, 700ms, 910ms, and 1120ms) of stimuli presentation on N2 amplitude across Go and NoGo conditions while taking into consideration covariates of BIS and BAS personality traits. There was a significant emotion x BIS Total interaction, $F(1, 20) = 7.028$, $p = .015$ for 280ms condition, and a significant emotion x BAS Total interaction, $F(1, 22) = 4.602$, $p = .043$ for 910ms condition.

No other main effects or interactions were observed. In order to examine the significant interactions observed for the 280ms condition and the 910ms condition, two separate post hoc correlation analyses were completed involving emotional valence (positive and negative) and corresponding scores on BIS and BAS. For the 280ms condition, directional post hoc correlation analyses indicated that the N2d for positive stimuli at the 280ms condition (P1611) (*M* =-11.455 microvolts, *SD* = 16.648) had a strong zero-order correlation in the opposite direction as hypothesized with participants' BIS Total self-report scores (*M* = 15.330 microvolts, *SD* = 3.397), *r* = .549, *n* = 24, *p* = .967, 95% CI [0.187, 0.780], while the N2d for negative stimuli at the 280ms condition (N1611) (*M* = -10.962 microvolts, SD = 14.544) did not significantly or strongly correlate with BIS Total. While these findings are in opposition to the hypothesis that greater BIS scores would be associated with increased N2d amplitudes for negative stimuli, it is interesting to note that the correlation between BIS scores and N2d for positive stimuli at this duration would have reached significance if the directional hypothesis was predicted correctly. Figure 8 illustrates NoGo and Go N2 amplitudes during the 280ms duration condition for positive stimuli presentation, while Figure 10 illustrates the same information for negative stimuli presentation. Figures 9 and 11 illustrate N2d waves during the 280ms duration condition for positive and negative stimuli presentation, respectively.

For the 910ms condition, directional post hoc correlation analyses indicated that the N2d for negative stimuli at the 910ms condition (N1914) (*M* =-10.846 microvolts, *SD* = 8.380) had a strong zero-order correlation in the opposite direction as hypothesized with participants' BAS Total self-report scores (*M* = 23.230 microvolts, *SD* = 5.101), *r* =

.496, *n* = 26, *p* = .995, 95% CI [0.134, 0.741],while the N2d for positive stimuli at the 910ms condition (*M* = -11.591 microvolts, *SD* = 11.731) did not significantly or strongly correlate with BAS Total. These findings are in opposition to the hypothesis that greater BAS scores would be associated with increased N2d amplitudes for positive stimuli presentation, but it is again important to note that the strong correlation would have reached significance if the directional hypotheses were correctly predicted and also if non-directional hypotheses were employed. Figure 12 illustrates NoGo and Go N2 amplitudes during the 910ms duration condition for positive stimuli presentation, while Figure 14 illustrates the same information for negative stimuli presentation. Figures 13 and 15 illustrate N2d waves during the 910ms duration condition for positive and negative stimuli presentation, respectively.

Figure 4. Go and NoGo N2 ERP Grand Averages for Positive Condition at Electrode FZ

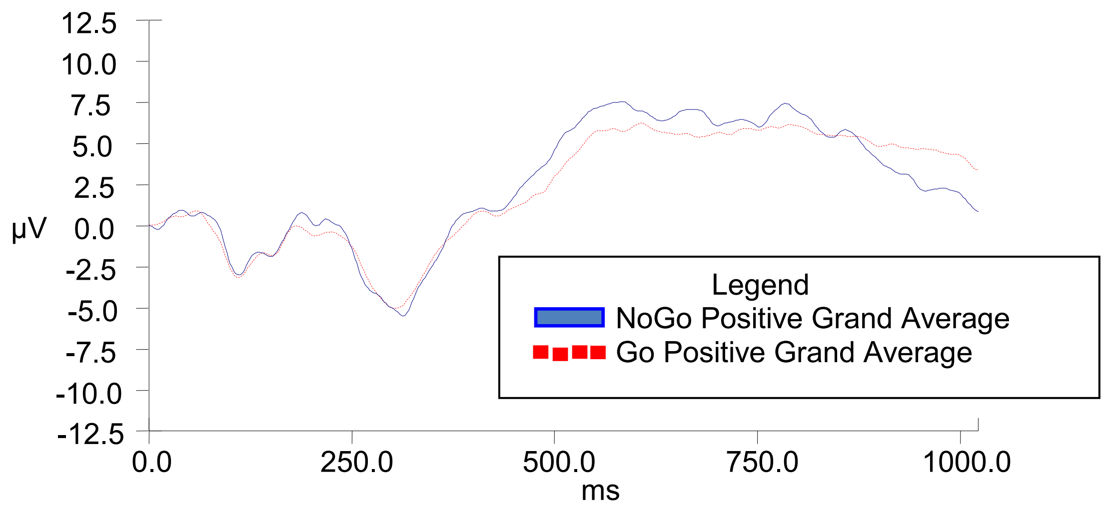


Figure 5. N2d (NoGo-Go) Grand Average for Positive Condition at Electrode FZ

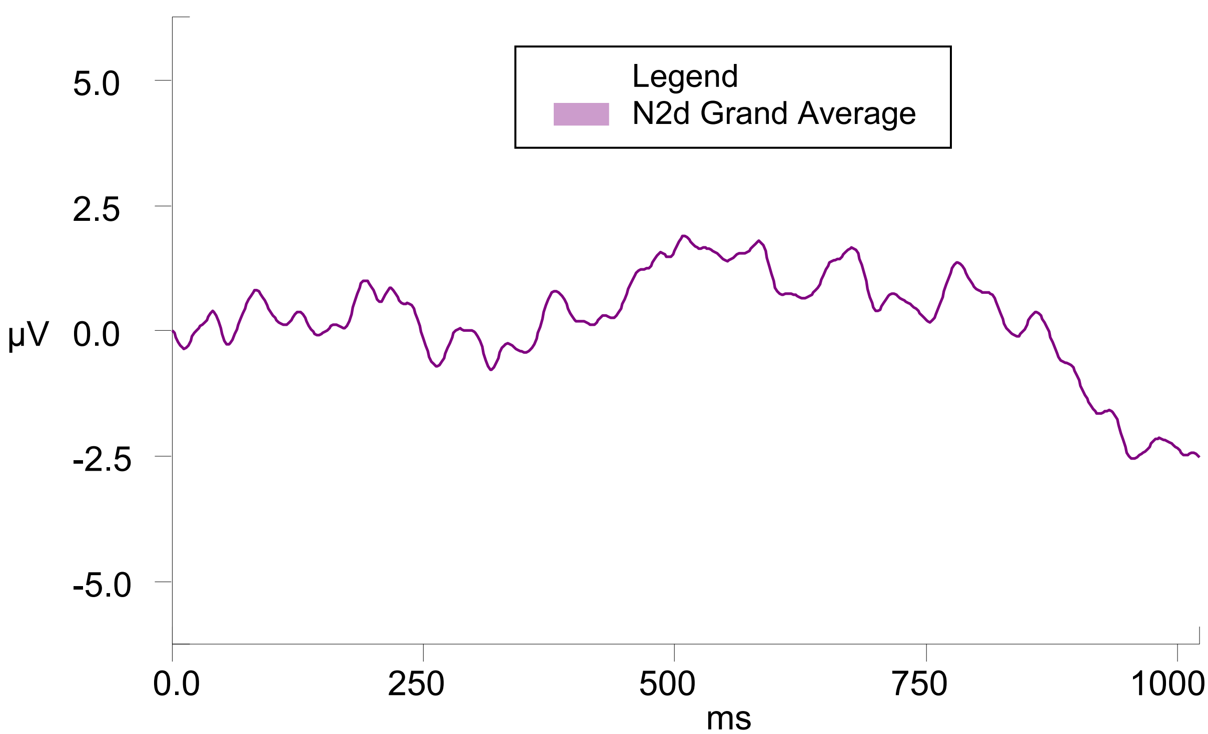


Figure 6. Go and NoGo N2 ERP Grand Averages for Negative Condition at Electrode FZ

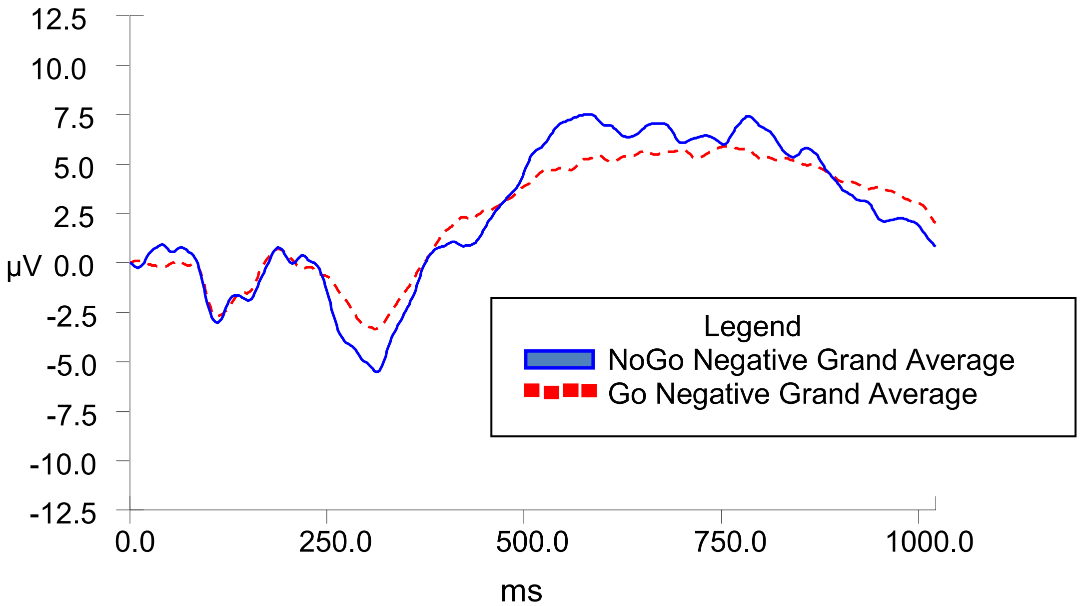


Figure 7. N2d (NoGo-Go) Grand Average for Negative Condition at Electrode FZ

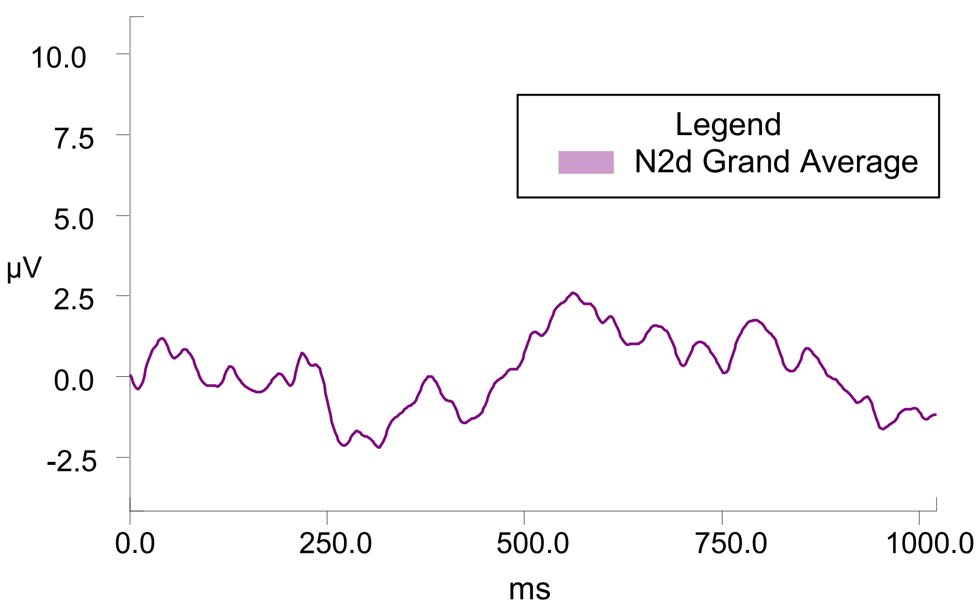


Figure 8. Go and NoGo N2 ERP Grand Averages for 280ms Positive Condition at Electrode FZ

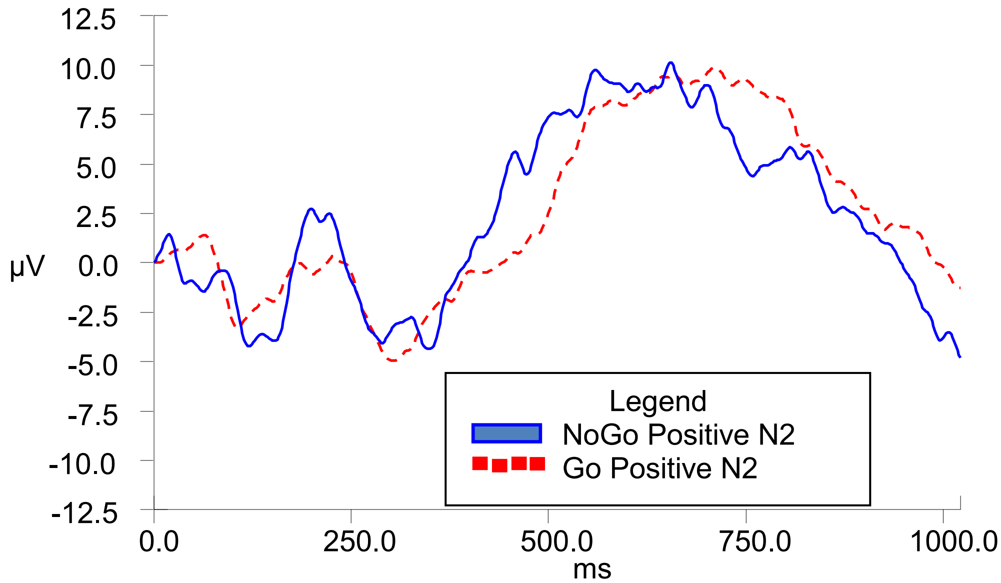


Figure 9. N2d (NoGo-Go) Grand Average for 280ms Positive Condition at Electrode FZ

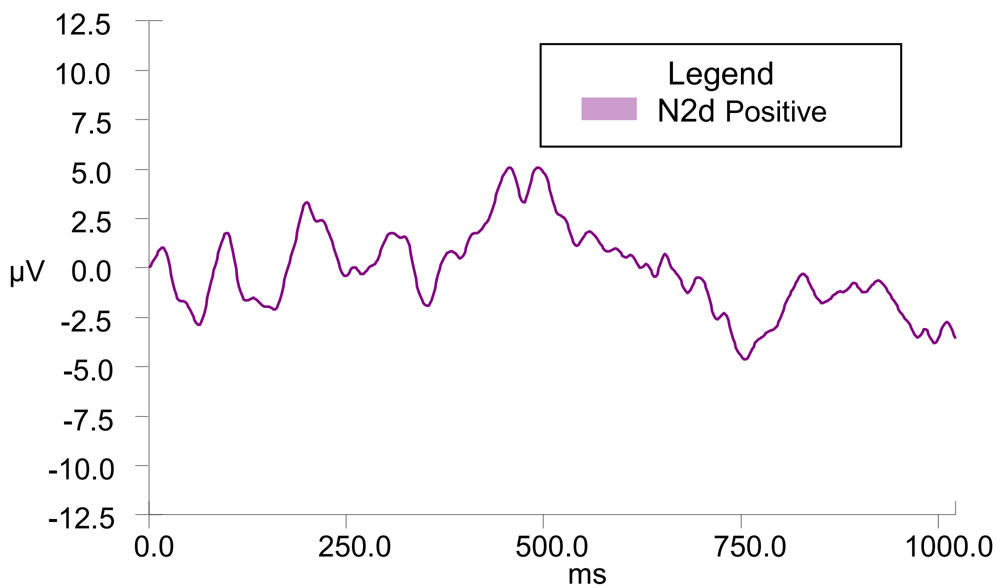


Figure 10. Go and NoGo N2 ERP Grand Averages for 280ms Negative Condition at Electrode FZ

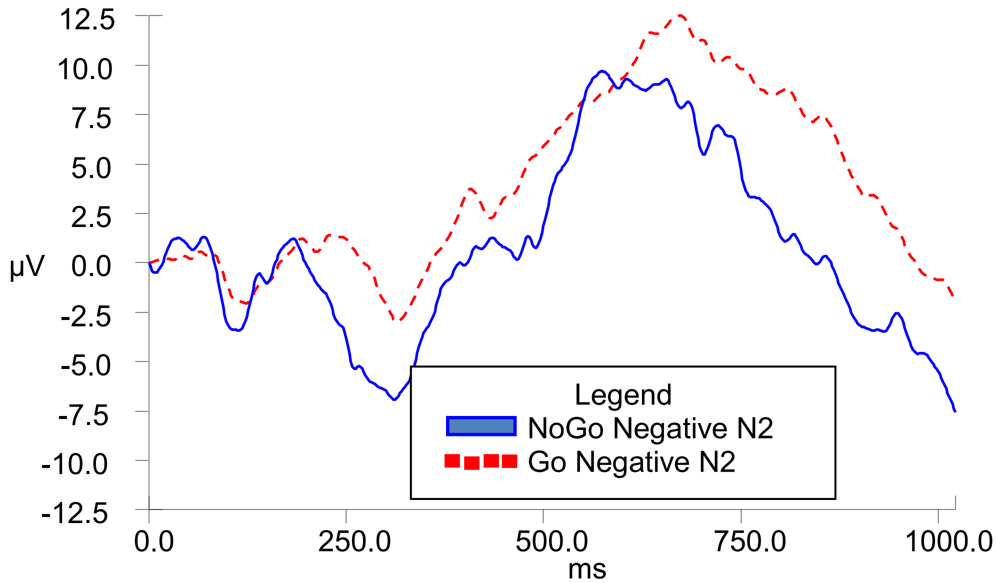


Figure 11. N2d (NoGo-Go) Grand Average for 280ms Negative Condition at Electrode FZ

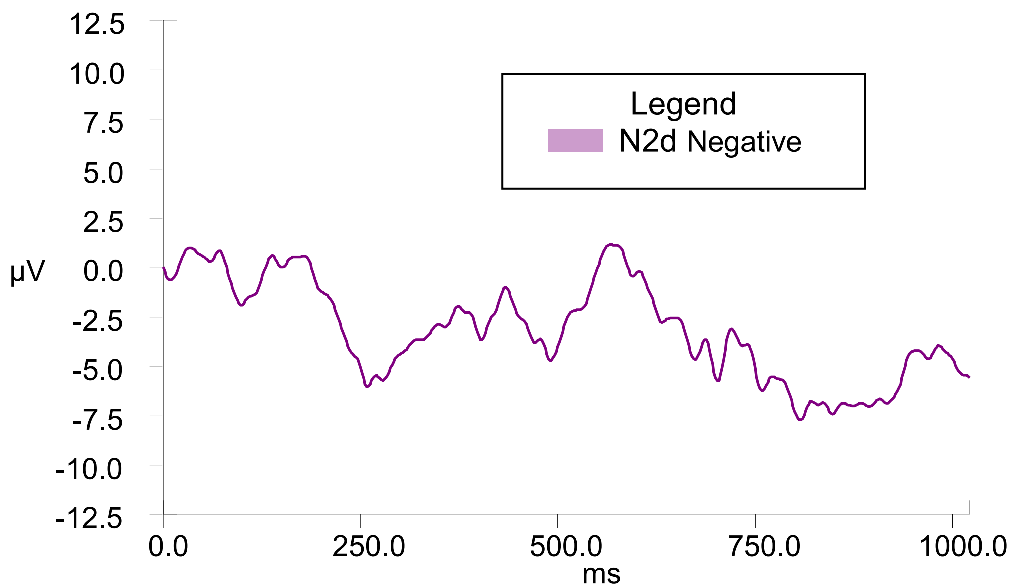


Figure 12. Go and NoGo N2 ERP Grand Averages for 910ms Positive Condition at Electrode FZ

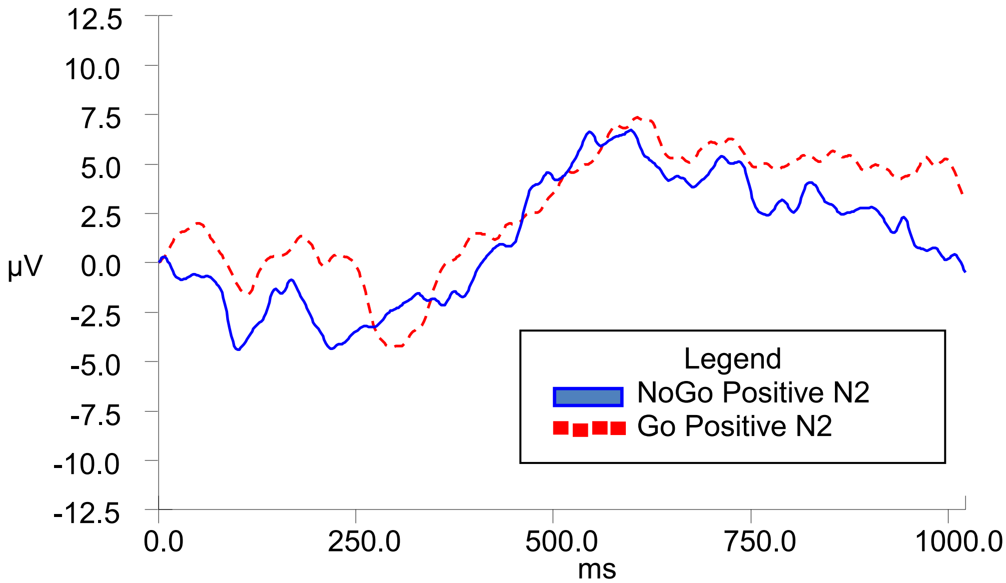


Figure 13. N2d (NoGo-Go) Grand Average for 910ms Positive Condition at Electrode FZ

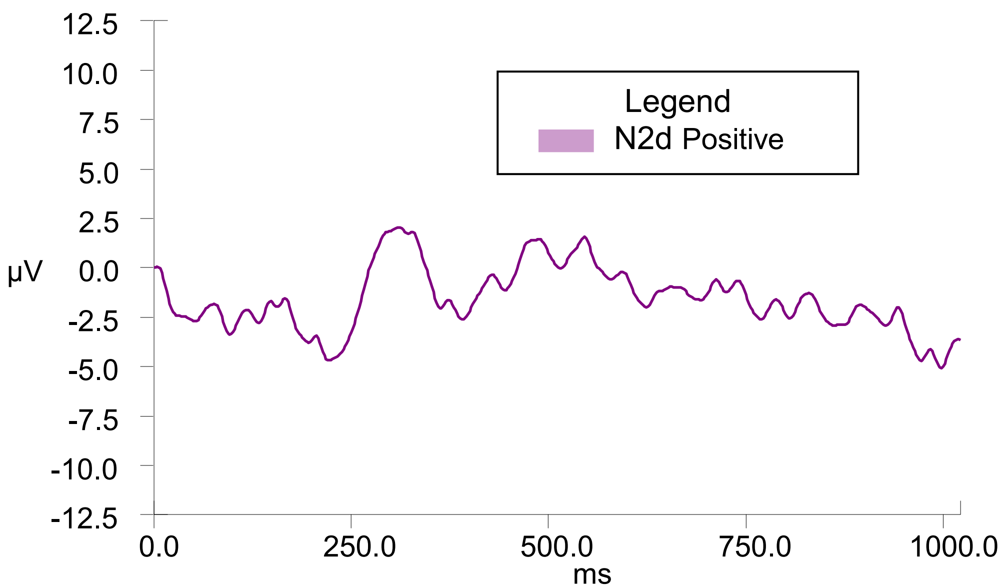


Figure 14. Go and NoGo N2 ERP Grand Averages for 910ms Negative Condition at Electrode FZ

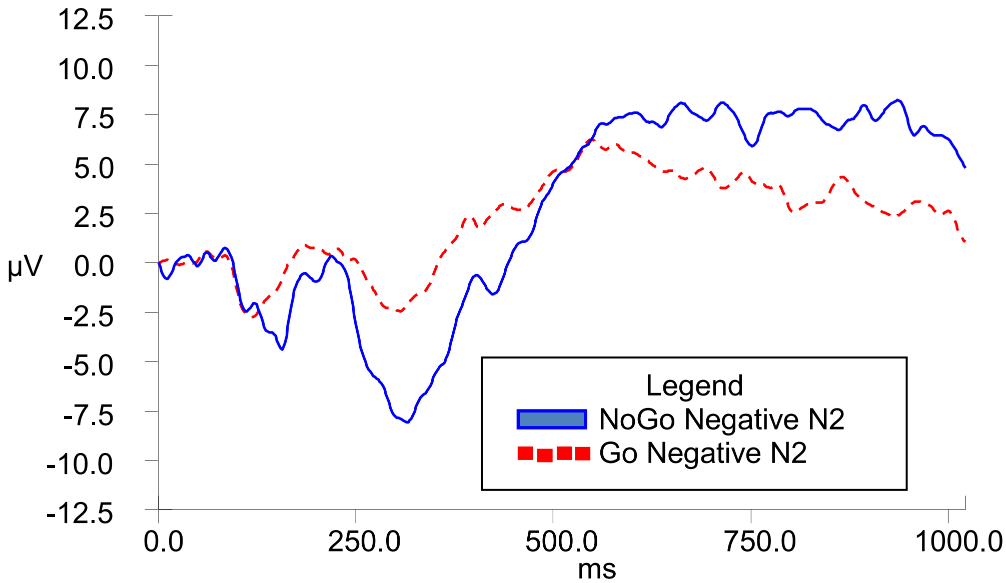
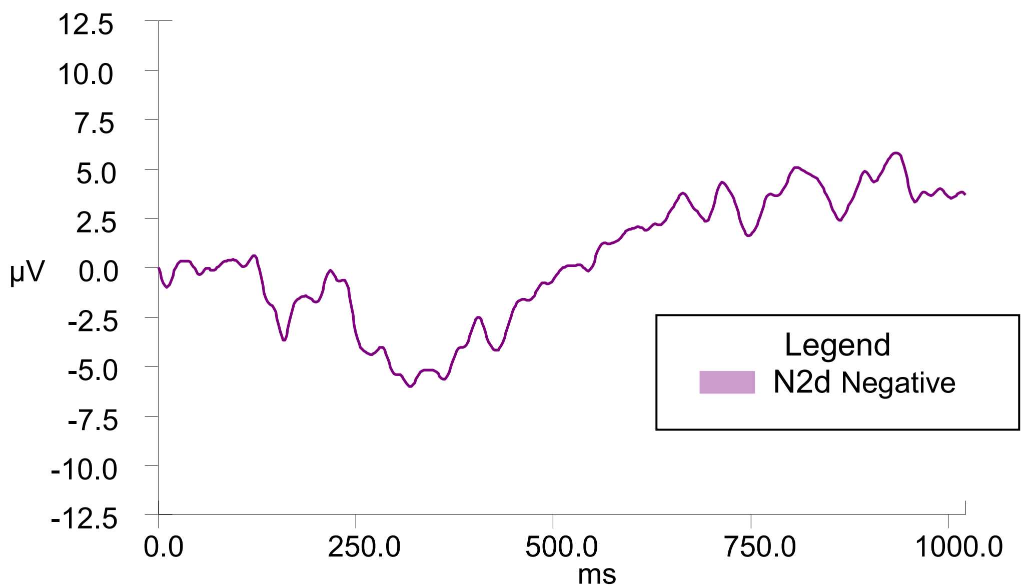


Figure 15. N2d (NoGo-Go) Grand Average for 910ms Negative Condition at Electrode FZ



Hypothesis Three: Personality and Resting Asymmetry

Results for evaluation of assumptions of normality indicated a positively skewed leptokurtic distribution of resting frontal activity, which was corrected with natural logarithmic transformations. Initial exclusions due to artifact resulted in a total sample *n* of 42 participants for correlation analysis. Power analysis indicated that this sample size would yield power of 62% for a medium-sized effect ($\rho = .3$).

Frontal asymmetry scores were calculated for overall alpha power, as well as for high, medium, and low alpha by subtracting left alpha power scores from right alpha power scores at frontal electrodes (ln[alpha power at F4 electrode] – ln[alpha power at F3 electrode]). Since the inverse of this asymmetry score is thought to represent increased brain activity, negative scores are thought to reflect greater relative right hemisphere EEG activity, whereas positive scores reflect greater relative left activity (Davidson, 1988). Frontal asymmetry data were collected from comfortably-seated participants during four one-minute eyes open and eyes closed phases. During the eyes open phases, participants were asked to relax and sit still while naturally looking forward for one minute durations. During the eyes closed phases, participants were asked to relax and naturally close their eyes while continuing to relax and sit still for one minute durations. These phase alternated as follows: eyes open (EO1), eyes closed (EC1), eyes open (EO2), and eyes closed (EC2).

In order to determine the relationship between BIS, BAS, and frontal asymmetry, directional correlation analyses were performed. Basic descriptive statistics and zero-order correlation coefficients between BIS, BAS subscales, and overall alpha asymmetry scores are presented in Table 4. Self-reported BAS Drive (BAS D) scores

(*M* = 10.13, *SD* = 3.25) were significantly, positively correlated with EO1 (*M* = .0573 microvolts, *SD* = .158), *r* = .267, *n* = 42, *p* = .044, 95% CI [0.010, 0.491]. These findings lend support to the hypothesis that higher self-reported BAS scores would be associated with greater relative left hemisphere EEG activation. No other significant correlations were found between other BAS subscales and asymmetry scores, nor were significant correlations found between BIS scores and asymmetry scores for overall alpha power (8-12 Hz).

In order to further investigate hypothesis 3, alpha power was separated by high, middle, and low alpha asymmetry scores. Table 5 provides basic descriptive statistics and zero-order correlations between BIS and BAS self-report scores and high alpha asymmetry scores. No significant correlations were found between these variables. Table 6 provides basic descriptive statistics and zero-order correlations between the same self-report variables and medium alpha asymmetry scores. A significant positive correlation was found between BAS D (*M* = 10.130, *SD* = 3.245) and middle alpha asymmetry during the EO1 condition (*M* = .0658 microvolts, *SD* = .196), *r* = .259, *n* = 42, *p* = .049, 90% CI [0.0225, 0.468]. This finding suggests greater relative left frontal EEG activity is correlated with increased BAS D self-report scores, which supports the hypothesis that increased BAS self-reports scores would be associated with greater left frontal asymmetry. Table 7 presents basic descriptive statistics and zero-order correlations between the same self-report variables and low alpha asymmetry scores. No significant correlations were found.

Table 4.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and overall alpha (8-12 Hz) asymmetry scores.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.488**
	RR								.178	.427**
	TOT							.599**	.819**	.833**
BIS							.195	.366**	-.019	.210
EO2						.006	-.078	-.159	-.046	-.007
EO1					.733**	-.037	.159	-.205	.267*	.108
EC2				.740**	.702**	-.0580	.142	.070	.137	.165
EC1			.810**	.708**	.613**	-.094	.141	-.153	.207	.118
Mean		.0953	.0938	.0573	.0462	15.690	22.490	4.930	10.130	7.420
SD		0.171	.208	.158	.157	4.033	5.849	1.864	3.245	2.491

*$p < .05$; **$p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking,EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 5.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and high alpha asymmetry scores.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.488**
	RR								.178	.427**
	TOT							.599**	.819**	.833**
BIS							.195	.366**	-.019	.210
EO2						-.080	.052	-.035	.071	.038
EO1					.714**	-.005	.100	-.030	.171	.001
EC2				.533**	.518**	-.194	.174	-.083	.175	.189
EC1			.705**	.497**	.367**	-.172	.172	-.111	.238	.116
Mean		.0756	.0849	.0506	.0338	15.690	22.490	4.930	10.130	7.420
SD		0.181	.230	.209	.198	4.033	5.849	1.864	3.245	2.491

$^{*}p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking,EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 6.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and middle alpha asymmetry scores.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.488**
	RR								.178	.427**
	TOT							.599**	.819**	.833**
BIS							.195	.366**	-.019	.210
EO2						-.017	-.152	-.210	-.152	.009
EO1					.580**	.026	.158	-.285	.259*	.164
EC2				.675**	.608**	-.053	.087	-.214	.115	.164
EC1			.720**	.606**	.536**	-.095	.230	-.142	.252	.242
Mean		.1037	.0751	.0658	.0514	15.690	22.490	4.930	10.130	7.420
SD		0.195	.241	.196	.195	4.033	5.849	1.864	3.245	2.491

*$p < .05$; **$p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking,EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 7.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and low alpha asymmetry scores.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.488**
	RR								.178	.427**
	TOT							.599**	.819**	.833**
BIS							.195	.366**	-.019	.210
EO2						.325	.070	-.044	.035	.130
EO1					.445**	.006	.125	-.040	.129	.119
EC2				.415**	.316*	.163	-.068	-.054	-.104	.026
EC1			.769**	.514**	.356**	.069	-.033	-.205	.040	.000
Mean		.0875	.112	.0528	.0362	15.690	22.490	4.930	10.130	7.420
SD		.206	.230	.204	.208	4.033	5.849	1.864	3.245	2.491

*$p < .05$; **$p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking,EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

To further investigate these conflicting findings, data were stratified by sex and directional correlation analyses were repeated separately. Table 8 illustrates correlations between BIS and BAS self-report scores and overall alpha asymmetry scores for women. Significant positive correlations were found between BAS D self-report scores (*M* = 11.00, *SD* = 3.142) and EO1 overall alpha asymmetry scores (*M* = .0605 microvolts, *SD* = .174), *r* = .348, *n* = 31, *p* = .028, 90% CI [0.052, 0.588], as well as between BAS D (*M* = 11.00, *SD* = 3.142) and EC1 (*M* = .0835 microvolts, *SD* = .165),), *r* = .341, *n* = 31, *p* = .030, 90% CI [0.044, 0.582]. These findings indicate greater relative left asymmetry was associated with greater BAS self-report scores, which supports hypothesis three.

Alpha power was again separated into high, medium, and low power for women. Table 9 shows correlations for high alpha power. Significant positive correlations were found between BAS TOT (*M* = 23.410, *SD* = 6.026) and high alpha power asymmetry scores EC1 (*M* = .0689 microvolts, *SD* = .175), *r* = .308, *n* = 31, *p* = .046, 90% CI [0.0075, 0.558], as well as between BAS D (*M* = 11.00, *SD* = 3.142) and EC1 (*M* = .0689 microvolts, *SD* = .175), *r* = .307, *n* = 31, *p* = .047, 90% CI [0.0064, 0.557]. These findings lend further support to hypothesis three.

Table 10 shows correlational data for women's middle alpha asymmetry scores with BIS and BAS self-report scores. As a result, additional support for hypothesis three was found in several significant correlations. BAS TOT (*M* = 23.410, *SD* = 6.026) was significantly correlated with EC1 (*M* = .0911 microvolts, *SD* = .185), *r* = .367, *n* = 31, *p* = .021, $CI_{.95}$ [0.015, 0.638]. In particular, BAS D (*M* = 11.000, *SD* = 3.142) was significantly correlated with EC1 (*M* = .0911 microvolts, *SD* = .185), *r* = .428, *n* = 31, *p* =

.008, $CI_{.95}$ [0.087, 0.679], and BAS FS (*M* = 7.410, *SD* = 2.500) was significantly correlated with EC1 (*M* = .0911 microvolts, *SD* = .185), *r* = .318, *n* = 31, *p* = .040, 90% CI [0.0185, 0.565]. BAS D (*M* = 11.000, *SD* = 3.142) was also significantly correlated with EO1 (*M* = .0847 microvolts, *SD* = .208), *r* = .358, *n* = 31, *p* = .024, $CI_{.95}$ [0.005, 0.632]. These findings suggest that women's self-report BAS scores, especially BAS D and BAS FS subscales, were positively correlated with greater relative left EEG activity, which supports hypothesis three. Correlational analyses were completed for low alpha asymmetry scores, as well, but no significant correlations were found between self-report BIS and BAS scores and low alpha asymmetry scores for women (Table 11).

Table 8.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and overall alpha (8-12 Hz) asymmetry scores for women.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.583**
	RR								.125	.446**
	TOT							.605**	.808**	.877**
BIS							.473**	.494**	.346*	.281
EO2						-.138	-.072	-.196	.085	-.140
EO1					.775**	-.047	.178	-.215	.348*	.079
EC2				.741**	.751**	-.009	.146	-.047	.160	.145
EC1			.827**	.770**	.665**	-.116	.267	-.085	.341*	.198
Mean		.0835	.0916	.0605	.0243	14.63	23.41	5.00	11.00	7.41
SD		.165	.217	.174	.134	4.030	6.026	2.140	3.142	2.500

**p* < .05; ***p* < .01

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking,EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 9.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and high alpha asymmetry scores for women.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.583**
	RR								.125	.446**
	TOT							.605**	.808**	.877**
BIS							.473**	.494**	.346*	.281
EO2						-.122	.088	-.082	.146	.058
EO1					.788**	.007	.119	-.009	.199	.006
EC2				.501**	.498**	-.160	.233	-.035	.209	.266
EC1			.715**	.454**	.414*	-.192	.308*	-.003	.307*	.280
Mean		.0689	.0861	.0467	.0150	14.630	23.410	5.000	11.000	7.410
SD		.175	.225	.232	.184	4.030	6.026	2.140	3.142	2.500

$^*p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 10.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and middle alpha asymmetry scores for women.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.583**
	RR								.125	.446**
	TOT							.605**	.808**	.877**
BIS							.473**	.494**	.346*	.281
EO2						-.143	-.138	-.211	-.067	-.073
EO1					.626**	.072	.189	-.327	.358*	.167
EC2				.704**	.672**	-.058	.029	-.262	.137	.061
EC1			.783**	.712**	.525**	-.140	.367*	-.103	.428**	.318*
Mean		.0911	.0740	.0847	.0298	14.630	23.410	5.000	11.000	7.410
SD		.185	.258	.208	.178	4.030	6.026	2.140	3.142	2.500

$^{*}p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 11.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and low alpha asymmetry scores for women.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.583**
	RR								.125	.446**
	TOT							.605**	.808**	.877**
BIS							.473**	.494**	.346*	.281
EO2						.141	.098	-.037	.269	-.118
EO1					.365*	-.131	.138	-.062	.243	.024
EC2				.368**	.167	.176	-.033	.000	-.056	.000
EC1			.766**	.528**	.277	.051	.0150	-.172	.112	.002
Mean		.0695	.0884	.0322	-.010	14.630	23.410	5.000	11.000	7.410
SD		.220	.227	.224	.198	4.030	6.026	2.140	3.142	2.500

**p* < .05; ***p* < .01

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

The same directional correlational analyses were repeated for men ($n = 11$). Correlational data are presented in Table 12 showing relationships between BIS and BAS self-report scores and overall alpha asymmetry. No significant correlations were found between self-report data and asymmetry scores. Table 13 shows the relationships between the same variables for high alpha power. Again, no significant correlations were found.

Table 14 presents directional correlational data between the same variables for medium alpha power for men. Men's BAS FS scores ($M = 7.460$, $SD = 2.570$) were significantly positively correlated with EC2 ($M = .0780$ microvolts, $SD = .198$), $r = .547$, $n = 11$, $p = .041$, 90% CI [0.0325, 0.832], which supports hypothesis three.

Men's correlational data are presented for low alpha power in Table 15. BAS FS ($M = 7.460$, $SD = 2.570$) was significantly positively correlated with EO1 ($M = .111$ microvolts, $SD = .128$), $r = .557$, $n = 11$, $p = .038$, 90% CI [0.0468, 0.837]. BAS FS ($M = 7.460$, $SD = 2.570$) was also significantly positively correlated with EO2 ($M = .162$ microvolts, $SD = .188$), $r = .753$, $n = 11$, $p = .004$, $CI_{.95}$ [0.280, 0.931]. These findings suggest that greater BAS FS scores were associated with greater relative left hemisphere activity for men, which supports hypothesis three.

Table 12.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and overall alpha (8-12 Hz) asymmetry scores for men.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.431
	RR								.543*	.468
	TOT							.712**	.838**	.834**
BIS							-.285	-.103	-.562*	.038
EO2						-.094	.075	-.104	-.012	.174
EO1					.859**	.131	.026	-.128	-.194	.265
EC2				.778**	.697**	-.380	.170	-.215	.155	.227
EC1			.798**	.607*	.509	-.375	-.116	-.502	.097	-.099
Mean		.129	.0999	.0481	.106	18.310	20.230	4.770	8.000	7.460
SD		.190	.191	.109	.203	2.689	4.885	.927	2.483	2.570

$^{*}p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 13.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and high alpha asymmetry scores for men.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.431
	RR								.543*	.468
	TOT							.712**	.838**	.834**
BIS							-.285	-.103	-.562*	.038
EO2						-.369	.106	.153	.185	-.043
EO1					.588*	-.230	.055	-.217	.235	-.038
EC2				.777**	.575*	-.431	-.002	-.320	.127	.000
EC1			.690**	.781**	.255	-.376	-.167	-.621	.265	-.292
Mean		.0945	.0816	.0615	.0850	18.310	20.230	4.770	8.000	7.460
SD		.205	.256	.136	.233	2.689	4.885	.927	2.483	2.570

$^*p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 14.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and middle alpha asymmetry scores for men.

		EC1	EC2	EO1	EO2	BIS	BAS			
							TOT	RR	D	FS
BAS	FS									
	D									.431
	RR								.543*	.468
	TOT							.712**	.838**	.834**
BIS							-.285	-.103	-.562*	.038
EO2						-.060	-.061	-.272	-.154	.135
EO1					.661*	.366	-.192	-.042	-.589	.220
EC2				.592*	.504	-.093	.397	.104	.096	.547*
EC1			.595*	.450	.521	-.270	-.026	-.348	.033	.055
Mean		.139	.0780	.0126	.111	18.310	20.230	4.770	8.000	7.460
SD		.228	.198	.158	.233	2.689	4.885	.927	2.483	2.570

$^{*}p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Table 15.

Correlation matrix showing relationships between BIS Total, BAS Total, BAS Subscales, and low alpha asymmetry scores for men.

		EC1	EC2	EO1	EO2	BIS	BAS TOT	BAS RR	BAS D	BAS FS
BAS	FS									
	D									.431
	RR								.543*	.468
	TOT							.712**	.838**	.834**
BIS							-.285	-.103	-.562*	.038
EO2						.376	.440	-.077	.021	.753**
EO1					.669*	.230	.411	.164	.087	.557*
EC2				.602*	.565*	-.230	-.011	-.334	.053	.057
EC1			.796**	.310	.514	-.306	-.069	-.470	.124	-.055
Mean		.138	.179	.111	.162	18.310	20.230	4.770	8.000	7.460
SD		.155	.236	.128	.188	2.689	4.885	.927	2.483	2.570

$^*p < .05$; $^{**}p < .01$

Note. BIS = Behavioral Inhibition System Total, BAS TOT = Behavioral Activation System Total, BAS RR = Behavioral Activation System Reward Responsiveness, BAS D = Behavioral Activation System Drive, BAS FS = Behavioral Activation System Fun Seeking, EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition.

Exploratory Analyses

Additional post hoc correlational analyses were conducted between other self-reported scores related to impulsivity, sensation-seeking tendencies, and traditional personality traits. Table 16 shows relationships between Mini-IPIP subscales and overestimation bias scores. No significant correlations were found between these variables. Table 17 shows relationships between Sensation-Seeking Scale scores and overestimation bias scores. OENeg (M = 52.983, SD = 27.338) was significantly negatively correlated with Disinhibition (ZDis) subscale scores (M = 20.000, SD = 5.126), r = -.293, n = 37, p = .039, 90% CI [-0.525, -0.0197]. No significant correlations were found between Barratt Impulsiveness subscale scores and overestimation bias scores (Table 18). Post hoc correlational analyses were also conducted between overestimation bias scores and resting frontal asymmetry scores. Tables 19-22 present these data. Only one significant correlation was found between HEO1 (M = 0.0506, SD = 0.210) and OENeg (M = 52.983, SD = 27.338), r = .332, n = 36, p = .024, 95% CI [0.004, 0.595].

Table 16.

Correlation matrix showing relationships between Mini-IPIP subscale scores and overestimation bias scores.

	OEPos	OENeg	E	A	C	N	I
I							
N							.075
C						.070	-.308*
A					-.045	.117	.245
E				.402**	.073	-.081	-.001
OENeg			-.169	.013	-.161	.111	-.099
OEPos		.597**	-.133	-.059	-.251	.097	-.014
Mean	48.815	52.983	20.240	22.400	20.000	12.560	22.530
SD	25.339	27.338	4.787	2.957	5.126	4.071	3.395

*$p < .05$; **$p < .01$

Note. I = Intellect, N = Neuroticism, C = Conscientiousness, A = Agreeableness, E = Extraversion, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 17.

Correlation matrix showing relationships between Zuckerman Sensation-Seeking subscale scores and overestimation bias scores.

	OEPos	OENeg	ZBS	ZES	ZDis	ZTAS	ZTot
ZTot							
ZTAS							.546**
ZDis						-.067	.627**
ZES					-.028	.260*	.545**
ZBS				.136	.499**	-.118	.576**
OENeg			-.155	.232	-.293*	-.053	-.139
OEPos		.597**	.048	.219	-.058	.012	.071
Mean	48.815	52.983	20.240	22.400	20.000	12.560	22.530
SD	25.339	27.338	4.787	2.957	5.126	4.071	3.395

*$p < .05$; **$p < .01$

Note. ZTot = Zuckerman Total, ZTAS = Thrill and Adventure-Seeking, ZDis = Disinhibition, ZES = Experience-Seeking, ZBS = Boredom Susceptibility, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 18.

Correlation matrix showing relationships between Barratt Impulsiveness subscale scores and overestimation bias scores.

	OEPos	OENeg	BCC	BSC	BP	BM	BCI	BA	BTot
BTot									
BA									.008
BCI								-.157	-.048
BM							-.006	-.004	.386**
BP						.119	-.038	.021	.693**
BSC					.137	-.106	-.463**	-.356*	.466**
BCC				.242	-.056	-.197	-.189	-.131	.247
OENeg			-.060	-.280	-.064	.004	.067	-.052	-.244
OEPos		.597**	.300	.064	-.265	-.122	-.201	.023	-.139
Mean	48.815	52.983	11.070	13.98	11.55	17.32	7.14	12.55	79.59
SD	25.339	27.338	1.421	2.51	1.934	2.154	1.679	1.704	5.059

**p* < .05; ***p* < .01

Note. BTot = Barratt Total, BA = Attention, BCI = Cognitive Instability, BM = Motor, BP = Perseverance, BSC = Self-Control, BCC = Cognitive Complexity, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 19.

Correlation matrix showing relationships between overall alpha (8-12 Hz) asymmetry scores and overestimation bias scores.

	OEPos	OENeg	EC1	EC2	EO1	EO2
EO2						
EO1						.733**
EC2					.740**	.702**
EC1				.810**	.708**	.613**
OENeg			-.028	-.062	.125	-.014
OEPos		.597**	-.113	-.125	-.011	-.078
Mean	48.815	52.983	.0953	.0938	.0573	.0462
SD	25.339	27.338	.171	.2015	.158	.157

*$p < .05$; **$p < .01$

Note. EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 20.

Correlation matrix showing relationships between high alpha asymmetry scores and overestimation bias scores.

	OEPos	OENeg	EC1	EC2	EO1	EO2
EO2						
EO1						.714**
EC2					.533**	.518**
EC1				.705**	.497**	.367**
OENeg			.171	-.015	.332*	.208
OEPos		.597**	-.013	.029	.198	.154
Mean	48.815	52.983	.0756	.0849	.0506	.0338
SD	25.339	27.338	.181	.230	.209	.198

*$p < .05$; **$p < .01$

Note. EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 21.

Correlation matrix showing relationships between middle alpha asymmetry scores and overestimation bias scores.

	OEPos	OENeg	EC1	EC2	EO1	EO2
EO2						
EO1						.580**
EC2					.675**	.608**
EC1				.720**	.606**	.536**
OENeg			-.015	-.067	.028	-.143
OEPos		.597**	-.059	-.148	-.048	-.157
Mean	48.815	52.983	.1037	.0751	.0658	.0514
SD	25.339	27.338	.195	.241	.196	.195

*$p < .05$; **$p < .01$

Note. EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

Table 22.

Correlation matrix showing relationships between low alpha asymmetry scores and overestimation bias scores.

	OEPos	OENeg	EC1	EC2	EO1	EO2
EO2						
EO1						.445**
EC2					.415**	.316**
EC1				.769**	.514**	.356**
OENeg			-.176	-.071	-.061	-.093
OEPos		.597**	-.113	-.125	-.011	-.078
Mean	48.815	52.983	.0875	.1122	.0528	.0362
SD	25.339	27.338	.206	.230	.204	.208

**p* < .05; ***p* < .01

Note. EC1 = alpha asymmetry score for eyes closed 1 condition, EC2 = alpha asymmetry score for eyes closed 2 condition, EO1 = alpha asymmetry score for eyes open 1 condition, EO2 = alpha asymmetry score for eyes open 2 condition, OEPos = Overstimation Bias Scores Positive Go Stimuli, OENeg = Overestimation Bias Scores Negative Go Stimuli.

CHAPTER V: CONCLUSION

Discussion

The purpose of the present study was three-fold: 1. To examine the relationship between levels of BIS and BAS, emotion, and perceived stimulus duration. 2. To use an affective Go/NoGo task to compare the effects that BIS and BAS, stimulus duration, and stimulus valence have on the inhibitory N2 ERP component. 3. To replicate findings of BIS and BAS resting asymmetry correlates.

Summary of Results. The main findings related to hypothesis one included significant correlations between overestimation bias scores and BIS and BAS self-report scores. Hypothesis one posited that higher BAS scores would be associated with greater overestimation bias scores for positive stimuli presentation, based on previous findings in the literature that visual emotional stimuli evoked arousal, and higher BAS scores were associated with sensitivity to reward and positive emotionality while BIS was associated with sensitivity to anxiety, novelty, and punishment. The second part of hypothesis one was that higher BIS scores would be associated with greater overestimation bias scores for negative stimuli presentation on the same premise. While both positive and negative stimuli presentation did elicit overestimation biases as predicted, findings indicated that higher BAS scores were associated with overestimation bias scores for both negative and positive stimuli presentation, while BIS scores were not significantly correlated with overestimation bias scores. BAS Drive subscale scores were main contributors to this partial support of hypothesis one, and while these self-report scores were significantly correlated with overestimation bias scores for both positive and negative stimuli presentation, the association was stronger for positive stimuli presentation. When data for hypothesis one were stratified by sex, women's BAS Drive scores were significantly correlated with overestimation bias scores for positive stimuli presentation, while no such relationship was evidenced for men's BAS subscale scores. This may indicate the need to test for sex-related differences in affective time perception according to personality traits in the future.

Support for the first part of hypothesis two was found, which stated that N2 amplitudes would be greater in response to "NoGo" than to "Go" stimuli presentations, indicating that the novel affective Go/NoGo task successfully elicited the N2 component thought to be associated with inhibition. Partial support for the second part of hypothesis two was observed. It was hypothesized that higher BIS scores would be associated with greater N2d difference waves for negative stimuli presentation and higher BAS scores would be associated with greater N2d difference waves for positive stimuli presentation. Indeed, N2d difference waves differentiated across personality trait levels; however, higher BIS Total scores were associated with higher N2d amplitudes during positive stimulus presentation for 280ms, while higher BAS Total scores were associated with higher N2d amplitudes during negative stimuli presentation for 910ms. These findings are in opposition to previous findings indicating stronger neurophysiological responses of high BAS and BIS scorers to positive and negative stimuli presentation, respectively (Balconi et al., 2009).

Results were mixed from hypothesis three, which posited that higher BIS scores would be associated with greater relative right frontal hemisphere EEG activity while higher BAS scores would be associated with greater relative left frontal hemisphere

EEG activity. BAS Drive scores were consistently and strongly correlated with greater relative left hemisphere asymmetry. Some correlational anomalies were found, such as higher BAS RR scores for women and men (separately) were associated with greater relative right hemisphere asymmetry at middle alpha power, along with the finding that higher BIS was associated with greater relative left hemisphere activity for analyses including all participants in the low alpha level. Another mixed finding was that greater BAS D was associated with greater relative right hemisphere activity for men at the middle alpha power level. In general, the data for women were more consistent with previous research in that BAS D was associated with greater relative left hemisphere asymmetry, while the opposite was found for men. These differences should be interpreted with caution as the data for men were suspect in part due to a low sample size and also due to the sampling bias of summer athletes who were fatigued, most likely poorly motivated, and most likely experiencing greater levels of negative mood.

Partial Support for Arousal-Based Models of Time Perception. Results from hypothesis one indicated that regardless of stimulus valence, the tendency to overestimate time duration was associated with higher BAS self-report scores, especially BAS Drive. BAS Drive items are used to assess a participant's strong and quick persistence to obtain goals. Perhaps this trait in particular is a measure of baseline arousal levels on which people vary their perceptions of time passing for even very quick durations. It has been discussed in the literature that visual emotional stimuli evokes arousal, theoretically speeding up the internal clock via the pacemaker mechanism. Findings from the present study may suggest that BAS Drive trait is sensitive to the pacemaker. These findings are generally in line with previous personality research indicating that people who scored higher on extraversion trait were more likely to overestimate durations of time than to make underestimations. Making underestimations would have been supportive of attentional-based models of time perception, while making overestimations as was demonstrated in extraverts supported an arousal-based model of time perception (Davidson & House, 1982; Rammsayer, 1997; Zakay, Lomranz, & Kaziniz, 1984).

Significant positive relationships between BAS D and greater relative left hemisphere activity during baseline EEG recording also offer support for arousal-based models of time perception. Reinforcement Sensitivity Theory assumes that individual differences in resting cortical arousal are reflective of enduring personality traits. The finding that BAS D was indeed associated with greater relative left hemisphere activity thus supports arousal-based models of time perception in that these individual differences were observed while participants were not attending to any visual or auditory stimuli. No evidence was found supporting the hypothesis that BIS trait would be associated with greater relative right hemisphere asymmetry, suggesting several possibilities. One such possibility is that BIS trait may be more sensitive to attentional factors instead of arousal; however, this consideration cannot be determined from the current study due to sampling limitations. Several anomalies were observed that were contrary to previous research, including the finding that BAS D for men was associated with greater relative right hemisphere activity perhaps highlighting a sampling limitation or may be indicative of potential sex-related differences that could be further investigated in future research.

From a clinical perspective, it is interesting to note that BAS was associated with overestimation of positive and negative stimuli. Individuals with elevated BAS typically engage in positive, approach-related behavior, and are generally thought of as less anxious or fearful than individuals with elevated BIS. Although only speculatory, it is possible that individuals with elevated BAS (and associated left hemisphere cortical arousal patterns) are somewhat resilient to the effects of negative stimuli. In contrast, individuals with elevated BIS are thought to experience positive stimuli somewhat differently, to the extent that it could actually be perceived as negative. Although only in infant stages, there is a line of research that suggests that individuals with elevated BIS are less adherent to simple medical treatments (i.e. positive stimuli) that could improve quality of life and prevent long-term medical complications (Moran, Everhart, Davis, Wuensch, Lee & Demaree, 2011).

Greater N2 amplitudes for NoGo stimuli in general indicated an inhibitory response to emotionally incongruent stimuli as expected. The presence of the N2 indicates participants' use of orbitofrontal and anterior cingulate cortices, and reflects inhibition on a premotor level. Since previous research indicated that higher BAS and BIS scores were associated with more intense orientation and responses to positive and negative stimuli respectively, it was originally hypothesized that higher BAS self-report scores would be associated with greater N2d responses to positive stimuli while higher BIS self-report scores would be associated with greater N2d responses to negative stimuli assuming an arousal-based model of time perception. However, BIS Total scores were associated with greater N2d responses to positive stimuli, perhaps suggesting that positive stimuli were being perceived as relatively novel experiences to participants' general perception styles. BAS Total scores on the other hand were associated with greater N2d responses to negative stimuli, again suggesting an orientation to novel stimuli that were incongruent to participants' general perception styles. These findings are contrary to arousal-based models of time perception and past research involving individual differences (Tipples, 2008), and indeed may be indicative of attentional mechanisms involved in time perception.

Tipples (2008) found support for arousal-based time perception models, in that negative emotionality was associated with overestimations of angry and fearful stimuli presentation durations. It was suggested that attentional effects were not observed in that study because they were mediated by emotional arousal through noradrenaline, which affects the operation of both attentional and time processes, and is also thought to facilitate orienting and slower disengagement of attention. Since the current study found results in opposition to arousal-based models of time perception, perhaps the Go/NoGo task tapped the previously-described attentional mechanisms that were sensitive to both noradrenergic and dopaminergic pathways that are implicated in BIS and BAS, respectively. Of note, the Tipples (2008) study differs fundamentally from the present study in two ways. First, the former study utilized affective faces rather than objects (i.e., IAPS). The negative affective faces were perceived as more arousing than positive affective faces. In the present study, the perceived levels of arousal for positive and negative stimuli were controlled for. To this extent, the significant effects noted within Tipples (2008) study may be attributable to the differences in magnitude of arousal between positive and negative affective faces. Second, Tipples (2008) did not examine BIS and BAS; rather, the EAS Temperament Survey was used (Buss &

Plomin, 1984) While this survey is associated with individual differences in positive and negative temperament, and may overlap with BAS and BIS, there are inherent differences between these constructs that make direct comparison impossible.

Furthermore, findings indicated that higher BAS scores were associated with greater N2d amplitudes at the negative 910ms duration condition (longer than the standard duration), while higher BIS scores were associated with greater N2d amplitudes at the positive 280ms duration condition (shorter than the standard duration). Assuming that the Go/NoGo task was able to tap attentional mechanisms along with their respective neurophysiological pathways, perhaps individuals who score higher BAS are more sensitive to attentional mechanisms at relatively longer durations of incongruent emotional stimuli than higher BIS scorers.

This study has advanced current understanding of time perception by integrating factors of emotional valence and personality characteristics. While previous research incorporating broad personality traits (e.g., extraversion and introversion) consists of conflicting findings, the current study offers results that support a more specific personality correlate with time overestimation tendencies known as BAS Drive. The novel affective Go/NoGo time perception task was also successful at eliciting the inhibitory N2 component, and may be adapted for use in future research as a potential way to further investigate neurophysiological correlates of time perception.

Limitations and Suggestions for Future Research

A major limitation to the present study was the inability to compare emotional conditions to neutral conditions. Including a neutral condition in future studies may help researchers isolate further arousal mechanisms associated with emotion. Also finding a way to measure participants' perceptions of "NoGo" stimuli presentation durations could be used as a means to further elucidate the effects of inhibition on time perception. Since there was no comparison made between "Go" and "NoGo" overestimation bias scores, the current study was unable to determine what role the N2 component serves in arousal- or attention-based models of time perception.

Another limitation was the amount of artifact encountered by taking N2d difference waves for hypothesis two. Increasing power in future studies by including more participants to account for this artifact may help detect findings the present study was unable to uncover. Previous research has included the use of a feedback tone for slow responses to "Go" stimuli, which helps to elicit the N2 ERP more reliably and effectively. This could also be a partial solution to decrease in power due to artifact if it results in clearer, more negative N2 amplitudes, meaning taking the N2d difference wave would no longer be necessary. The last main limitation to this study was the sampling bias of including summer semester students who were also student-athletes who were exhausted from practice by the time they arrived for participation in the study. Most of these student athletes were men, and stratifying data by sex for hypotheses one and three resulted in more consistent findings for women than men, although this could merely be a result of lower power for male participants in this sample, or even could indicate sex differences in time perception that could be further explored in the future.

Implications of this research include continued advancement of understanding cognitive domains affected in many different clinical populations, including ADHD, Parkinson's disease, mood disorders, and senescence as well as normal aging. Other research implications include psychotherapeutic applications, emphasizing the importance of taking individual differences into account during case conceptualization and treatment planning for patients with psychological disorders. Greater N2d amplitudes for incongruent emotional stimuli according to BIS and BAS perceptive styles highlighted the need for clinicians to consider the manner of presentation of proposed treatment plans to patients in psychotherapy, in that reactions and compliance will most likely differ, even at the cortical level, according to personality traits. Further research in these clinical areas is suggested and will help to illustrate the impact of individual differences on treatment outcomes.

REFERENCES

American Psychological Association. (2002). Ethical principles of psychologists and code of conduct. *American Psychologist*, *57*, 1060-1073.

Angrilli, A., Cherubini, P., Pavese, A., & Manfredini, S. (1997). The influence of affective factors on time perception. *Perception & Psychophysics, 59,* 972-982.

Balconi, M., Falbo, L., & Brambilla, E. (2009). BIS/BAS responses to emotional cues: Self report, autonomic measure and alpha band modulation. *Personality and Individual Differences, 47*, 858-863.

Beste, C., Dziobek, I., Hielscher, H., Willemssen, R., & Falkenstien, M. (2009). Effects of stimulus-response compatibility on inhibitory processes in Parkinson's disease. *European Journal of Neuroscience, 29*, 855-860.

Block, R.A., & Zakay, D. (1996). Models of psychological time revisited. In H. Helfrich (Ed.), *Time and mind* (pp. 171-195). Kirkland, WA: Hogrete & Huber.

Block, R.A., & Zakay, D. (1997). Prospective and retrospective duration judgments: A meta-analytic review. *Psychonomic Bulletin and Review, 4,* 184-197.

Bradley, M. M. & Lang, P. J. (2007). The International Affective Picture System (IAPS) in the study of emotion and attention. In J. A. Coan and J. J. B. Allen (Eds.), Handbook of Emotion Elicitation and Assessment (pp. 29-46). New York, NY: Cambridge University Press.

Buchwald, C., & Blatt, S.J. (1974). Personality and the experience of time. *Journal of Consulting and Clinical Psychology, 45*, 639-644.

Burle, & Casini, (2001). Dissociation between activation and attention effects in time estimation: implications for internal clock models. *Journal of Experimental Psychology: Human Perception and Performance,* 195-205.

Burle, B., Vidal, F., Tandonnet, C., & Hasbroucq, T. (2004). Physiological evidence for response inhibition in choice reaction time tasks. *Brain and Cognition, 56*, 153-164.

Buss, A. H., & Plomin, R. (1984). *Temperament: Early developing personality traits.* Hillsdale, NJ: Erlbaum.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment The BIS/BAS Scales. *Journal of Personality and Social Psychology, 67,* 319-333.

Casini, L., & Macar, F. (1997). Effects of attention manipulation on judgments of duration and of intensity in the visual modality. *Memory & Cognition, 25*, 812-818.

Chen, K., & Yeh, S. (2009). Asymmetric cross-modal effects in time perception. *Acta Psychologica, 130*, 225-234.

Claridge, G. (1960). The excitation-inhibition balance. In J. Eysenck, *Experiments in personality* (pp. 107-156). London, England: Routledge and Kegan Paul.

Coan, J.A., & Allen, J.J. (2003). Frontal EEG asymmetry and the behavioral activation and inhibition systems. *Psychophysiology, 40*, 106-114.

Coelho, M., Ferreira, J., Dias, B., Sampaio, C., Pavao, Martins, I., & Castro-Caldas, A. (2004). Assessment of time perception: The effect of aging, *Journal of International Neuropsychological Society,* 10, 332–341.

Coles, M.G., & Rugg, M.D. (1995). Event-related brain potentials: An introduction. In Electrophysiology of mind: Event-related brain potentials and cognition. Rugg, M.D. & Coles, M.G. (Eds.); (pp. 1-26) New York, NY, US: Oxford University Press.

Coren, S. Proac, C., & Duncan, P. (1979). A behaviorally validated self report inventory to assess four types of lateral preferences. *Journal of Clinical Neuropsychology, 1*, 55-64.

Danckert, J., Ferber, S., Pun, C., Broderick, C., Striemer, C., Rock, S., & Stewart, D. (2007). Neglected time: Impaired temporal perception of multisecond intervals in unilateral neglect. *Journal of Cognitive Neuroscience, 19,* 1706-1720.

Davidson, R. J. (1988). EEG measures of cerebral asymmetry: Conceptual and methodological issues. *The International Journal of Neuroscience, 39*, 71–89.

Davidson, W.B., & House, W.J. (1982). Personality and the perception of time: A multimethod examination. *Psychology: A Journal of Human Behavior, 19*, 7-11.

Demaree, H. A., Robinson, J. L., Everhart, D. E. & Youngstrom, E. A. (2005). Behavioral inhibition system (BIS) strength and trait dominance are associated with affective response and perspective taking when viewing dyadic interactions. *International Journal of Neuroscience, 115,* 1579-1593.

Demaree, H.A., Everhart, D.E., Youngstrom, E. A., & Harrison, D. W. (2005). Brain lateralization of emotional processing: Historical roots and a future incorporating “dominance”. *Behavioral and Cognitive Neuroscience Reviews, 4*, 3-20.

Donnellan, M.B., Oswald, F.L., Baird, B.M., & Lucas, R.E. (2006). The Mini-IPIP Scales: Tiny-yet-effective measures of the Big Five Factors of Personality. *Psychological Assessment, 18*, 192-203.

Droit-Volet, S., Brunot, S., & Niedenthal, P.M. (2004). Perception of the duration of emotional events. *Cognition and Emotion, 18*, 849-858.

Effron, D. A., Niedenthal, P. M., Gil, S., & Droit-Volet, S. (2006). Embodied temporal perception of emotion. *Emotion, 6,* 1-9.

Everhart, D. E., & Demaree, H. A. (2003). Healthy high hostiles evidence low alpha power (7.5-9.5Hz) changes during negative affective learning. *Brain and Cognition, 52*, 334-342.

Eysenck (1970). *The biological basis of personality*. Springfield, IL: C.C., Thomas.

Falkenstein, M., Hoormann, J., & Hohnsbein, J. (1999). ERP components in Go/Nogo tasks and their relation to inhibition. *Acta Psychologica, 101,* 267-291.

Falkenstein, M., Hoormann, J., Hohnsbein, J. (2002). Inhibition-related ERP components: variation with modality, age, and time-on-task. *Journal of Psychophysiology, 16*, 167-175.

Gan, T., Wang, N., Zhang, Z., Li, H., & Luo, Y. (2009). Emotional influences on time perception: evidence from event-related potentials. *Neuroreport,20,* 839-843.

Gibbon, J. (1977). Scalar expectancy theory and Weber's law in animal timing. *Psychological Review, 84*, 279-325.

Gibbon, J., Church, R.M., & Meck, Warren, H. (1984). Scalar timing in memory. *Annals of the New York Academy of Sciences, 423*, 52-77.

Gilchrist, H., Povey, R., Dickinson, A., & Povey, R. (1995). The Sensation Seeking Scale: Its use in a study of the characteristics of people choosing ‘adventure holidays’. *Personality and Individual Differences, 19*, 513-516.

Gilden, D. L., & Marusich, L. R. (2009). Contraction of time in Attention-Deficit Hyperactivity Disorder. *Neuropsychology, 23,* 265-269.

Gil, S., Niedenthal, P.M., & Droit-Volet, S. (2007). Anger and time perception in children. *Emotion, 7*, 219-225.

Gray, J.A. (1990). Brain systems that mediate both emotion and cognition. *Cognition and Emotion, 4*, 269-288.

Gray, C.T., Gray, C.R., & Loehlin, J.C. (1975). Time perception: Effects of introversion/extraversion and task interest. *Perceptual and Motor Skills, 41*, 703-708.

Gunstad, J., Coehn, R. A., Paul, R. H., Luyster, F. S., & Gordon, E. (2006). Age effects in time estimation: Relationship to frontal brain morphometry. *Journal of Integrative Neuroscience, 5,* 75-87.

Harmon-Jones, E., & Harmon-Jones, C. (2010). On the relationship of trait PANAS positive activation and trait anger: Evidence of a suppressor relationship. *Journal of Research in Personality, 44,* 120-123.

Hawkins, W.L., French, L.C., Crawford, B.D., & Enzle, M.E. (1988). Depressed affect and time perception. *Journal of Abnormal Psychology, 97*, 275-280.

Hogan, H.W. (1978). A theoretical reconciliation of competing views of time perception. *The American Journal of Psychology, 91*, 417-428.

Jasper, J. (1958). Report of the committee on methods of clinical examination in electroencephalography. *Electroencephalography and Clinical Neurophysiology, 10,* 370-375.

Jodo, E., & Kayama, Y. (1992). Relation of a negative ERP component to response inhibition in a Go/Nogo task. *Electroencephalography & Clinical Neurophysiology, 82*, 477-482.

Kirkcaldy, B.D. (1984). Individual differences in time estimation. *International Journal of Sport Psychology, 15*, 11-24.

LeDoux, J. E. (1995). Emotion: Clues from the brain. *Annual Reviews of Psychology, 46,* 209-235.

Lejeune, H. (1998). Switching or gating? The attentional challenge in cognitive models of psychological time. *Behavioural Processes, 44,* 127-145.

Lejeune, H. (2000). Prospective timing, attention, and the switch. A response to 'Gating or switching? Gating is a better model of prospective timing' by Zakay. *Behavioural Processes, 52,* 71-76.

Lomranz, J. (1983). Time estimation as a function of stimulus complexity and personality. *Social Behavior and Personality, 11*, 77-81.

Lynn, R. (1961). Introversion-extraversion differences in judgments of time. *The Journal of Abnormal and Social Psychology, 63*, 457-458.

Malapani, C., Rakitin, B., Levy, R., Meck, W.H., Deweer, B., Dubois, B., & Gibbon, J. (1998). Coupled temporal memories in Parkinson's disease: A dopamine-related dysfunction. *Journal of Cognitive Neuroscience, 10*, 316-331.

McGee, R., Brodeur, D., Symons, D., Andrade, B., & Fahie, C. (2004). Time perception: Does it distinguish ADHD and RD children in a clinical sample? *Journal of Abnormal Child Psychology, 32,* 481-490.

Meaux, J. B. & Chelonis, J. J. (2005). The relationship between behavioral inhibition and time perception in children. *Journal of Child and Adolescent Psychiatric Nursing, 18,* 148-160.

Meck, (1996). Dissecting the brain's internal clock: how frontal-striatal circuitry keeps time and shifts attention. *Brain and Cognition, 48*, 195-211.

Megill, J. L. (2003). What role do the emotions play in cognition? Towards a new alternative to cognitive theories of emotion. *Consciousness & Emotion, 4,* 81-100.

Moran, A.M. Everhart, D.E., Wuensch, K.L, Davis, C.E., Lee, D.O., Demaree, H.A. (2011). Personality Correlates of Adherence with Continuous Positive Airway Pressure (CPAP). *Sleep and Breathing, 15,* 687-694.

Noulhiane, M., Mella, N., Samson, S., Ragot, R., & Pouthas, V. (2007). How emotional auditory stimuli modulate time perception. *Emotion, 7*, 697-704.

O'Hanlon, J.F., McGrath, J.J., & McCauley, M.E. (1974). Body temperature and temporal acuity. *Journal of Experimental Psychology, 102*, 788-794.

Ohman, A., Lundqvist, D., & Esteves, F. (2001). The face in the crowd revisited: A threat advantage with schematic stimuli. *Journal of Personality and Social Psychology, 80*, 381-396.

Ornstein, R.E. (1970). On the experience of time. Oxford, England: Penguin Books.

Penton-Voak, I.S., Edwards, H., Percival, A., & Wearden, J.H. (1996). Speeding up an internal clock in humans? Effects of click trains on subjective duration. *Journal of Experimental Psychology, 22*, 307-320.

Priestly, J.B. (1968). *Man and time.* New York, NY: Dell Books.

Rammsayer,T.H. (1997). On the relationship between personality and time estimation. *Personality and Individual Differences, 23,* 739-744.

Rammsayer, T.H., & Classen, W. (1997). Impaired temporal discrimination in Parkinson's disease: Temporal processing of brief durations as an indicator of degeneration of dopaminergic neurons in the basal ganglia. *International Journal of Neuroscience, 91*, 45-55.

Rakitin, B., Stern, Y., & Malapani C. (2005). The effects of aging on time reproduction in delayed free-recall, *Brain Cognition,* 58, 17–34.

Reuter, M., Schmitz, A., Corr, P., & Hennig, J. (2006). Molecular genetics support Gray's personality theory: The interaction of COMT and DRD2 polymorphisms predicts the behavioural approach system. *International Journal of Neuropsychopharmacology, 9*, 155-166.

Rueda, A. D. & Schmitter-Edgecombe, M. (2009). Time estimation abilities in mild cognitive impairment and Alzheimer's disease. *Neuropsychology, 23,* 178-188.

Russell, J.A., & Mehrabian, A. (1977). Evidence for a three-factor theory of emotions. *Journal of Research in Personality, 11*, 273-294.

Sevigny, M., Everett, J., & Grondin, S. (2003). Depression, attention, and time estimation. *Brain and Cognition, 53,* 351-353.

Shaw, C. & Aggleton, J. P. (1994). The ability of amnesic subjects to estimate time intervals. *Neuropsychologia, 32,* 857-873.

Smith, J. G., Harper, D. N., Gittings, D., & Abernethy, D. (2007). The effect of Parkinson's disease on time estimation as a function of stimulus duration range and modality. *Brain and Cognition, 64,* 130-143.

Smith, A. B., Taylor, E., Brammer, M., Halari, R., & Rubia, K. (2008). Reduced activation in right lateral prefrontal cortex and anterior cingulated gyrus in medication-naïve adolescents with attention deficit hyperactivity disorder during time discrimination. *The Journal of Child Psychology and Psychiatry, 49,* 977-985.

Spinella, M. (2007). Normative data and a short form of the Barratt Impulsiveness Scale. *International Journal of Neuroscience, 117*, 359-368.

Sutton, S. K., & Davidson, R. J. (1997). Prefrontal brain asymmetry: A biological substrate of the behavioral approach and inhibition systems. *Psychological Science,8*(3), 204–210.

Taatgen, N. A., van Rijn, H., & Anderson, J. (2007). An integrated theory of prospective time interval estimation: The role of cognition, attention, and learning. *Psychological Review, 114,* 577-598.

Thayer, S., & Schiff, W. (1975). Eye-contact, facial expression, and the experience of time. *The Journal of Social Psychology, 95*, 117-124.

Thomas, E.A., & Weaver, W. B. (1975). Cognitive processing and time perception. *Perception and Psychophysics, 17*, 363-367.

Tipples, J. (2008). Negative emotionality influences the effects of emotion on time perception. *Emotion, 8,* 127-131.

Treisman, M. (1963). Temporal discrimination and the indifference interval: Implications for a model of the 'internal clock'. *Psychological Monographs: General and Applied, 77,* 1-31.

Treisman, M., Faulkner, A., Naish, P.L., & Brogan, D. (1990). The internal clock: Evidence for a temporal oscillator underlying time perception with some estimates of its characteristic frequency. *Perception, 19,* 705-743.

Treisman, M., Faulkner, A., & Naish, P.L. (1992). On the relation between time perception and the timing of motor action: Evidence for a temporal oscillator controlling the timing of movement. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 45A,* 235-263.

Watts, F., & Sharrock, R. (1984). Fear and time estimation. *Perceptual and Motor Skills, 59,* 597-598.

Wearden, J.H. (1992). Temporal generalization in humans. *Journal of Experimental Psychology: Animal Behavior Processes, 18,* 134-144.

Wearden, J.H. (1999). "Beyond the fields we know…": exploring and developing scalar timing theory. *Behavioural Processes, 45,* 3-21.

Wearden, J.H. (2008). Slowing down an internal clock: Implications for accounts of performance on four timing tasks. *The Quarterly Journal of Experimental Psychology, 61*, 263-274.

Wearden, J.H., Pilkington, R., & Carter, E. (1999). ‘Subjective lengthening’ during repeated testing of a simple temporal discrimination. *Behavioural Processes, 46,* 25-38.

Wearden, J.H., Smith-Spark, J.H., Cousins, R., Edelstyn, N.M., Cody, F.W., & O’Boyle, D. (2009). Effect click trains on duration estimates by people with Parkinson’s disease. *The Quarterly Journal of Experimental Psychology, 62*, 33-40.

Wudel, P. (1979). Time estimation and personality dimensions. *Perceptual and Motor Skills, 48,* 1320.

Yu, F., Yuan, J., & Luo, Y. (2009). Auditory-induced emotion modulates processes of response inhibition: an event-related potential study. *Neuroreport, 20*, 25-30.

Zakay, D. (1989). Subjective time and attentional resource allocation: An integrated model of time estimation. In I. Levin & D. Zakay (Eds.), *Time and human cognition: A life-span perspective* (pp.365-397). Amsterdam, Holland: North-Holland.

Zakay, D. (2000). Gating or switching? Gating is a better model of prospective timing (a response to ‘switching or gating?’ by Lejeune). *Behavioural Processes, 52*, 63-69.

Zakay D., & Block, R.A. (1995). Temporal cognition. *Current Directions in Psychological Science, 6,* 12-16.

Zakay, D., Lomranz, J., & Kaziniz, M. (1984). Extraversion-introversion and time perception. *Personality and Individual Differences, 5*, 237-239.

APPENDIX A: IRB DOCUMENTATION

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building• 600 Moye Boulevard • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**

TO: Katie Lehockey, Student, Dept. of Psychology, ECU—104 Rawl Building

FROM: UMCIRB

DATE: June 2, 2011

RE: Expedited Category Research Study

TITLE: "The Effects of Emotional States an Traits on Time Perception"

UMCIRB #11-0357

This research study has undergone review and approval using expedited review on 6.1.11. This research study is eligible for review under an expedited category number 4 & 7. The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **6.1.11** to **5.31.12**. The approval includes the following items:

- Internal Processing Form (dated 2.24.11)
- Informed Consent, Version 1 (dated 5.5.11)
- Recruitment Script (received date 6.1.11)
- Sensation-Seeking Scale
- BIS-11/BIS/BAS
- Lateral Preference Inventory
- Participant Information
- The Mini-IPIP

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.

1907-2007
CENTENNIAL
East Carolina University

UNIVERSITY HEALTH SYSTEMS
of Eastern Carolina

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: The Effects of Emotional States and Traits on Time Perception

Principal Investigator: Katie Lehockey
Institution/Department or Division: Department of Psychology, Thomas Harriot College of Arts and Sciences
Address: 104 Rawl Building, East Carolina University, Greenville, NC 27858
Telephone #: 252-561-5436

Researchers at East Carolina University (ECU) study problems in society, health problems, environmental problems, behavior problems and the human condition. Our goal is to try to find ways to improve the lives of you and others. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?
The purpose of this research is to find out how people with different personalities may think about time passing when they are put in positive and negative moods. We are also interested in investigating an important skill people have called inhibition. When people have problems with this skill, they might end up having problems in school, jobs, and relationships. The decision to take part in this research is yours to make. By doing this research, we hope to learn how inhibition is related to time perception across different personality types and moods.

Why am I being invited to take part in this research?
You are being invited to take part in this research because you are a healthy volunteer. If you volunteer to take part in this research, you will be one of about 55 people to do so.

Are there reasons I should not take part in this research?
I understand I should not volunteer for this study if I have a neurological or psychiatric condition (e.g., seizure disorder, traumatic brain injury, depression, anxiety, etc.), or have a cognitive impairment. I also understand that I should not participate in this research if I am under 18 years of age, or if I have impaired vision.

What other choices do I have if I do not take part in this research?
You can choose not to participate. Please speak with your psychology instructor for other available extra credit opportunities.

UMCIRB Number: 11-0357

Consent Version # or Date: Version 1, 5-5-11
UMCIRB Version 2010.05.01

UMCIRB
APPROVED
FROM 6-1-11
TO 5-31-12

____
Participant's Initials

Where is the research going to take place and how long will it last?
The research procedures will be conducted at the Rawl Building. You will need to come to the Cognitive Neuroscience Lab in Rawl 237 one time during the study. The total amount of time you will be asked to volunteer for this study is 2 hours today.

What will I be asked to do?
You are being asked to do the following:

- **Complete several surveys** for the first 30 minutes in order to investigate research questions. These surveys include the following:

  1. *Lateral Preference Inventory*. This scale will be used to assess which hand you use the most to do daily tasks, along with other features of your lateral preference. Demographic information will also be collected regarding your age and sex.

  2. *BIS/BAS Scales*. This scale will be used to measure your tendencies to avoid experiencing different feelings or participating in certain activities.

  3. *Sensation-Seeking Scale*. This scale will be used to measure your tendency to seek out adventure or boredom.

  4. *Mini IPIP*. This scale will be used to measure your personality traits.

  5. *Barratt Impulsiveness Scale*. This scale will be used to measure impulsivity.

- **Participate in EEG recording.** EEG is a recording of your brain's electrical activity. A recording of the normal electrical activity (waves) of your brain is taken by securing electrodes to your scalp with a saline solution (gel) that can be removed with warm water. We will place a fitted lycra electroencephalogram (EEG) electrode cap comfortably on your head and apply saline gel to your scalp for good conductance. We need to do this in order to understand the skill described earlier called inhibition. We may need to use medical tape, so *please* let us know now if you have any allergies, especially a *skin allergy*. We will use computer software to record EEG during the task. Preparations will take about 15 minutes.

- **Participate in the time perception task.** Directions to complete the time perception task will be given after you are fitted with the EEG cap. Results from this task will provide us with information that will be used to answer important research questions about time perception and inhibition. The task will take about 40 minutes to complete, and will consist of three parts:

  1. *Learning Phase.* During this phase, you will be shown a picture 10 times for the same amount of time.

2. *Practice Phase.* You will be shown different pictures and will be asked to respond to certain pictures using a keypad. Your response will be based on your judgment of how long you saw certain pictures.

3. *Testing Phase.* This phase will be much like the Practice Phase, but with different pictures.

- Once you have completed all surveys and the task, you will be allowed to ask any questions about the experiment, and may leave when you are ready.

What possible harms or discomforts might I experience if I take part in the research?
It has been determined that the risks associated with this research are no more than what you would experience in everyday life.

What are the possible benefits I may experience from taking part in this research?
We do not know if you will get any benefits by taking part in this study. This research might help us learn more about the effects of emotion and personality traits on time perception and inhibition. This information may add to current models of time perception and inhibition, which could provide some benefit to clinical populations who have problems with these skills. There may be no personal benefit from your participation but the information gained by doing this research may help others in the future.

Will I be paid for taking part in this research?
We will not be able to pay you for the time you volunteer while being in this study. You may earn extra credit in your psychology course for your participation, depending upon the policy of your instructor.

What will it cost me to take part in this research?
It will not cost you any money to be part of the research.

Who will know that I took part in this research and learn personal information about me?
To do this research, ECU and the people and organizations listed below may know that you took part in this research and may see information about you that is normally kept private. With your permission, these people may use your private information to do this research:

- Any agency of the federal, state, or local government that regulates human research. This includes the Department of Health and Human Services (DHHS), the North Carolina Department of Health, and the Office for Human Research Protections.
- The University & Medical Center Institutional Review Board (UMCIRB) and its staff, who have responsibility for overseeing your welfare during this research, and other ECU staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?
Data will be stored in a locked filing cabinet within a locked room in the Rawl Building. Raw data will be stored until analyses are completed, and will then be destroyed. Only the principal investigator and the contact person will have access to data. The names of participants will be stripped from electronic data and instead, participants will be identified by a number. Thus, privacy will be maintained using numeric codes for raw data collection and analyses.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will not lose any benefits that you should normally receive.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research, now or in the future. You may contact the Principal Investigator at 252-561-5436 (days, 8am-5pm).

If you have questions about your rights as someone taking part in research, you may call the Office for Human Research Integrity (OHRI) at phone number 252-744-2914 (days, 8:00 am-5:00 pm). If you would like to report a complaint or concern about this research study, you may call the Director of the OHRI, at 252-744-1971.

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

____

Participant's Name (PRINT) **Signature** **Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above, and answered all of the person's questions about the research.

____

Person Obtaining Consent (PRINT) **Signature** **Date**

____

Principal Investigator (PRINT) **Signature** **Date**
(If other than person obtaining informed consent)

APPENDIX B: CARVER & WHITE'S (1994) BIS/BAS SCALES

BIS/BAS

Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses. Choose from the following four response options:

1 = very true for me
2 = somewhat true for me
3 = somewhat false for me
4 = very false for me

______ 1. A person's family is the most important thing in life.
______ 2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
______ 3. I go out of my way to get things I want.
______ 4. When I'm doing well at something I love to keep at it.
______ 5. I'm always willing to try something new if I think it will be fun.
______ 6. How I dress is important to me.
______ 7. When I get something I want, I feel excited and energized.
______ 8. Criticism or scolding hurts me quite a bit.
______ 9. When I want something I usually go all-out to get it.
______ 10. I will often do things for no other reason than that they might be fun.
______ 11. It's hard for me to find the time to do things such as get a haircut.
______ 12. If I see a chance to get something I want I move on it right away.
______ 13. I feel pretty worried or upset when I think or know somebody is angry at me.
______ 14. When I see an opportunity for something I like I get excited right away.
______ 15. I often act on the spur of the moment.
______ 16. If I think something unpleasant is going to happen I usually get pretty "worked up."
______ 17. I often wonder why people act the way they do.
______ 18. When good things happen to me, it affects me strongly.
______ 19. I feel worried when I think I have done poorly at something important.
______ 20. I crave excitement and new sensations.
______ 21. When I go after something I use a "no holds barred" approach.
______ 22. I have very few fears compared to my friends.
______ 23. It would excite me to win a contest.
______ 24. I worry about making mistakes.

APPENDIX C: MINI-IPIP SCALE

The Mini-IPIP

Here are a number of personality traits that may or may not apply to you. Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. You should rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.

1 = Disagree strongly
2 = Disagree moderately
3 = Disagree a little
4 = Neither agree nor disagree
5 = Agree a little
6 = Agree moderately
7 = Agree strongly

1. I see myself as the life of the party. _________
2. I sympathize with others' feelings. _________
3. I get chores done right away. _________
4. I have frequent mood swings. _________
5. I have a vivid imagination. _________
6. I don't talk a lot. _________
7. I am not interested in other people's problems. _________
8. I often forget to put things back in their proper place. _________
9. I am relaxed most of the time. _________
10. I am not interested in abstract ideas. _________
11. I talk to a lot of different people at parties. _________
12. I feel others' emotions. _________
13. I like order. _________
14. I get upset easily. _________
15. I have difficulty understanding abstract ideas. _________
16. I keep in the background. _________
17. I am not really interested in others. _________
18. I make a mess of things. _________
19. I seldom feel blue. _________
20. I do not have a good imagination. _________

APPENDIX D: BARRATT IMPULSIVENESS SCALE (BIS-11)

The Barratt Scale: BIS-11

For each statement below, please rate yourself on the following scale:

Rarely/Never 1 2 3 4 Always/Almost Always

1. I "squirm" at plays or lectures. _______
2. I am restless at the theater of lectures _______
3. I don't "pay attention" _______
4. I concentrate easily _______
5. I am a steady thinker _______
6. I act "on impulse" _______
7. I act on the spur of the moment _______
8. I buy things on impulse _______
9. I make up my mind quickly _______
10. I do things without thinking. _______
11. I spend or charge more than I earn. _______
12. I am happy-go-lucky. _______
13. I am a careful thinker. _______
14. I plan tasks carefully. _______
15. I am self-controlled. _______
16. I plan trips well ahead of time. _______
17. I plan for job security. _______
18. I say things without thinking. _______
19. I like to think about complex problems. _______
20. I like puzzles. _______
21. I save regularly. _______
22. I am more interested in the present than the future. _______
23. I get easily bored when solving thought problems. _______
24. I change residences _______
25. I change jobs. _______
26. I am future oriented. _______
27. I can only think about one problem at a time. _______
28. I often have extraneous thoughts when thinking. _______
29. I have "racing" thoughts. _______
30. I change hobbies. _______

APPENDIX E: ZUCKERMAN'S SENSATION-SEEKING SCALE

Zuckerman's Scale

For each question, please indicate which of the choices most describes your likes or the way you feel. When it is hard to choose, select the option that describes you best of that you dislike the least.

1. a. I like "wild" uninhibited parties. ______
   b. I prefer quiet parties with good conversation.

2. a. There are some movies I enjoy seeing a second or third time. ______
   b. I can't stand watching a movie that I've just seen before.

3. a. I often wish I could be a mountain climber. ______
   b. I can't understand people who risk their necks climbing mountains.

4. a. I dislike all body odors. ______
   b. I like some of the earthy body smells.

5. a. I get bored seeing the same old faces. ______
   b. I like the comfortable familiarity of everyday friends.

6. a. I like to explore a strange city or section of town by myself, even if it means getting lost. ______
   b. I prefer a guide when I am in a place I don't know well.

7. a. I dislike people who do or say things just to shock or upset others. ______
   b. When you can predict almost everything a person will do or say he must be a bore.

8. a. I usually don't enjoy a movie or play where I can predict what will happen in advance. ______
   b. I don't mind watching a movie or play where I can predict what will happen in advance.

9. a. I have tried cannabis or would like to. ______
   b. I would never smoke cannabis.

10. a. I would not like to try any drug which might produce strange and dangerous effects on me. ______
    b. I would like to try some of the drugs that produce hallucinations.

11. a. A sensible person avoids activities that are dangerous. ______
b. I sometimes like to do things that are a little frightening.

12. a. I dislike “swingers” (people who are uninhibited and free about sex). ______
b. I enjoy the company of real “swingers”.

13. a. I find that stimulants make me uncomfortable. ______
b. I often like to get high (drinking alcohol or smoking marijuana).

14. a. I like to try new foods that I have never tasted before. ______
b. I order the dishes with which I am familiar so as to avoid disappointment or unpleasantness.

15. a. I enjoy looking at home movies, videos, or travel slides. ______
b. Looking at someone’s home movies, videos, or travel slides bores me tremendously.

16. a. I would like to take up the sport of water skiing. ______
b. I would not like to take up water skiing.

17. a. I would like to try surfboard riding. ______
b. I would not like to try surfboard riding.

18. a. I would like to take off on a trip with no preplanned or definite routes or timetable. ______
b. When I go on a trip I like to plan my route and timetable carefully.

19. a. I prefer the “down to earth” kinds of people as friends. ______
b. I would like to make friends in some of the “far out” groups like artists or anarchists.

20. a. I would not like to learn to fly an airplane. ______
b. I would like to learn to fly an airplane.

21. a. I prefer the surface of the water to the depths. ______
b. I would like to go scuba diving.

22. a. I would like top meet some people who are homosexual (men or women). ______
b. I stay away from anyone I suspect of being gay or lesbian.

23. a. I would like to try parachute jumping. ______
b. I would never want to try jumping out of an airplane, with or without a parachute.

24. a. I prefer friends who are excitingly unpredictable. ______
b. I prefer friends who are reliable and predictable.

25. a. I am not interested in experience for its own sake. ______
b. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal.

26. a. I would not like to learn to fly an airplane. ______
b. I would like to learn to fly an airplane.

27. a. I prefer spending time in the familiar settings of home. ______
b. I get very restless if I have to stay around home for any length of time.

28. a. I like to dive off the high board. ______
b. I don't like the feeling I get standing on the high board (or I don't go near it at all).

29. a. I like to date people who are physically exciting. ______
b. I like to date people who share my values.

30. a. Heavy drinking usually ruins a party because some people get loud and boisterous. ______
b. Keeping the drinks full is the key to a good party.

31. a. The worst social sin is to be rude. ______
b. The worst social sin is to be a bore.

32. a. A person should have considerable sexual experience before marriage. ______
b. It's better if two married people begin their sexual experience with each other.

33. a. Even if I had the money, I would not care to associate with flighty rich people in the jet set. ______
b. I could conceive of myself seeking pleasures around the world with the jet set.

34. a. I like people who are sharp and witty even if they do sometimes insult others. ______
b. I dislike people who have their fun at the expense of hurting the feelings of others.

35. a. There is altogether too much portrayal of sex in the movies. ______
b. I enjoy watching many of the sexy scenes in movies.

36. a. I feel best after taking a couple of drinks. ______
b. Something is wrong with people who need alcohol to feel good.

37. a. People should dress according to some standard of taste, neatness, and style. ______
b. People should dress in individual ways even if the effects are sometimes strange.

38. a. Sailing long distances in small sailing crafts is foolhardy. ______
b. I would like to sail a long distance in a small but seaworthy sailing craft.

39. a. I have no patience with dull or boring people. ______
b. I find something interesting in almost every person I talk to.

40. a. Skiing down a high mountain slope is a good way to end up on crutches. ______
b. I think I would enjoy the sensations of skiing very fast down a high mountain slope.

APPENDIX F: LATERAL PREFERENCE INVENTORY

Lateral Preference Inventory

Participant #:________

Circle the appropriate number after each item.

	Right	**Left**	**Both**
With which hand would you throw a ball to hit a target?	1	-1	0
With which hand do you draw?	1	-1	0
With which hand do you use an eraser on paper?	1	-1	0
With which hand do you remove the top card when dealing?	1	-1	0
With which foot do you kick a ball?	1	-1	0
If you wanted to pick up a pebble with your toes, which foot would you use?	1	-1	0
If you had to step up onto a chair, which foot would you place on the chair first?	1	-1	0
Which eye would you use to peep through a keyhole?	1	-1	0
If you had to look into a dark bottle to see how full it was, which eye would you use?	1	-1	0
Which eye would you use to sight down a rifle?	1	-1	0
If you wanted to listen to a conversation going on behind a closed door, which ear would you place against the door?	1	-1	0
If you wanted to listen to someone's heartbeat, which ear would you place against their chest?	1	-1	0
Into which ear would you place the earphone of a transistor radio?	1	-1	0

Is mother left or right hand dominant? ____

Is father left or right hand dominant? ____

# of Right + # of Left = Total Score

---------- + --------- = -------------

APPENDIX G: PARTICIPANT INFORMATION QUESTIONNAIRE

Participant Information

Participant No. _________

Age (in years):___ Sex (please circle one): Male Female Ethnicity:____________________

Medical History Questionnaire

Have you ever experienced or been diagnosed with any of the following, or are you experiencing any of the following at present? Please circle the appropriate response and explain any "Yes" answers below.

1. Visual difficulties, blurred vision, or eye disorders	Yes	No
2. Blindness in either eye	Yes	No
3. If Yes to either of the above, have problems been corrected	Yes	No
4. Hearing problems	Yes	No
5. Learning disabilities (problems of reading, writing, or comprehension)	Yes	No
6. Cognitive problems	Yes	No
7. Severe head trauma/injury	Yes	No
8. Stroke	Yes	No
9. Epilepsy or seizures	Yes	No
10. Neurological surgery	Yes	No
11. Paralysis	Yes	No
12. Anxiety disorders	Yes	No
13. Depression	Yes	No
14. Other Neurological, Psychological, or Emotional problems	Yes	No

Please explain any "Yes" responses:

____

____

APPENDIX H: RECRUITMENT FROM SUMMER CLASSES SCRIPT

Recruitment Script

Greetings!

My name is Katie Lehockey and I am a clinical health psychology doctoral student conducting research to complete my thesis. I'm here today to see if anyone is interested in participating in my experiment.

The purpose of my research is to find out how people with different personalities may think about time passing when they are put in positive and negative moods. I am also interested in investigating an important skill people have called inhibition. When people have problems with this skill, they might end up having problems in school, jobs, and relationships. By doing this research, I hope to learn how inhibition is related to time perception across different personality types and moods.

If you are interested in participating, you will be asked to come to the Cognitive Neuroscience Lab in the Rawl building for two hours. During the first half hour, you will complete some surveys about your personality and feelings. The rest of the time you will be completing the experiment. It is important to note that this study will use electroencephalogram (EEG). EEG is a recording of your brain's electrical activity, which is very useful for studying inhibition.

If you are 18 years of age or older, right-handed, have corrected-to-normal vision, and do not have any neurological or psychiatric conditions like a seizure disorder, anxiety, or depression, then you are eligible to participate in this study. Please indicate your interest in participating by printing your name and contact information on the paper provided. I will contact you with more information about the study as soon as possible. You may also contact me with any questions or concerns you may have about the experiment or your eligibility to participate.

Thank you for your time and consideration!

APPENDIX I: EXPERIMENT INSTRUCTIONS

General Instructions

You are now ready to begin the experimental phases of this session. You are sitting in a sound-proof booth, so I will be talking to you through an intercom system periodically. If you need something throughout the experiment, please pick up your mouse and point the bottom part towards the left booth where I'll be sitting.

It is very important that you remain still and relaxed during these sessions. Please do not grind your teeth or clinch your jaw. Please do not move your face more than usual, and try not to touch your face. If you feel one of the electrodes falling off of your face or ears, please pick up your mouse and point the bottom part towards me.

Part of the challenge of this experiment is for you to pay close attention at all times. This test can get very boring, so please try your best to stay alert and answer the items correctly.

At the end of the experiment, you will complete a brief quiz about what you saw during testing. You should do very well on it if you pay attention ☺

Eyes Open, Eyes Closed

For the next 4 minutes, I will be asking you to open and close your eyes over the intercom.

When I ask you to open your eyes, I’d like for you keep your eyes open normally and to look at the computer screen in front of you.

When I ask you to close your eyes, simply close your eyes naturally without squinting or moving many of your facial muscles.

Learning Phase Instructions

During this part of the experiment, you will learn what we will refer to as the "standard duration."

You will see a series of 10 pictures. They are all the same picture, and will be presented for the same amount of time. I want you to pay close attention to the pictures, especially focusing on the amount of time they are displayed. The amount of time each picture is displayed will be your reference point for the next tasks.

Practice Phase Instructions

During this part of the experiment, you will learn how to do the task and practice responding.

You will be presented with many different pictures, including the gray oval you saw 10 times before. Each of these pictures will be displayed for different amounts of time. Your job is to determine if each picture is displayed for an amount of time that is shorter or longer than the "standard duration" that you just learned. Please indicate if you think each picture is presented for an amount of time that is shorter or longer than the "standard" by using the mouse. If you think the picture was displayed for a shorter amount of time than the "standard," press the left mouse click as soon as you see "Please Respond" on the screen. If you think the answer is "longer," press the right mouse click. ***Only use your RIGHT hand to respond to items!***

Short = Left button

Long = Right button

Only respond to the pictures other than the gray oval. When the gray oval appears for any duration, do **not** do anything when you see "Please Respond." Simply wait for the next picture to appear.

Test Phase Instructions (Positive-Negative)

During this part of the experiment, you will do basically the same thing you did in the last part, but with different pictures.

There are two trials in this part. Each part will have pictures that will make you experience positive or negative feelings.

Part 1

During the first trial, you will see many pictures that make you experience positive feelings. When you see a picture that makes you feel positive emotions, you are to choose if it was displayed for an amount of time that is shorter or longer than the "standard duration" when you see "Please Respond." You are to use the mouse the same way you did in the last part of the experiment.

You will also see some negative pictures during this trial. When you see pictures that make you feel negative emotions, do **not** respond when you see "Please Respond." Instead, just wait for the next stimulus to appear.

Part 2

You will do the opposite for the second trial. You will see many negative pictures, and choose whether they were displayed for an amount of time that is shorter or longer than the "standard duration." When you see positive pictures, do **not** respond when you see "Please Respond." Just wait for the next stimulus to appear.

Test Phase Instructions (Negative-Positive)

During this part of the experiment, you will do basically the same thing you did in the last part, but with different pictures.

There are two trials in this part. Each part will have pictures that will make you experience positive or negative feelings.

Part 1

During the first trial, you will see many pictures that make you experience negative feelings. When you see a picture that makes you feel negative emotions, you are to choose if it was displayed for an amount of time that is shorter or longer than the "standard duration" when you see "Please Respond." You are to use the mouse the same way you did in the last part of the experiment.

You will also see some positive pictures during this trial. When you see pictures that make you feel positive emotions, do **not** respond when you see "Please Respond." Instead, just wait for the next stimulus to appear.

Part 2

You will do the opposite for the second trial. You will see many positive pictures, and choose whether they were displayed for an amount of time that is shorter or longer than the "standard duration." When you see negative pictures, do **not** respond when you see "Please Respond." Just wait for the next stimulus to appear.