ANTICIPATORY RESPONSE IN CONTINGENT NEGATIVE VARIATION DURING HAPPY FACE Go TASK IN PERSONS WITH SCHIZOTYPY AND ANHEDONIA

A thesis submitted in partial fulfillment of the requirements For the degree of Master of Arts in Psychology, Clinical Psychology

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Dedication

For my parents and sister whose unwavering support and encouragement has been an important part of my success and accomplishments.
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Abstract

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The purpose of this study was to examine the relationship between schizotypy, anhedonia, and CNV amplitude. Schizotypy is considered a subclinical manifestation of the same psychotic symptoms identifiable in schizophrenia-spectrum disorders and lies on a continuum. Utilizing this population offers invaluable material for research in regards to the central features of schizophrenia as schizotypes are not exposed to the confounding elements of antipsychotic medications, chronic social deficits, cognitive decline, and frequent hospitalization as are individuals with schizophrenia. Studies of neurocognition of individuals with schizophrenia and schizotypy offer an understanding in various aspects of deficits, such as attention, working and spatial memory, emotion recognition and response inhibition. The current study examines anticipatory response in schizotypy and anhedonia population using electroencephalography (EEG) measure using a continuous performance task (CPT). “Psychometric schizotypes” were identified by their elevated scores on Schizotypal Personality Questionnaire-Brief. Participants’ brain wave activity were recorded during a CPT associated with emotion recognition. The contingent negative variation amplitudes were analyzed at the frontal, central and posterior leads for each task. Participants also responded to questions on the Revised Physical Anhedonia Scale (RSAS) as a measure of the individual’s ability to experience
pleasure from physical stimuli such as food, sex and settings, and the Revised Social Anhedonia (RSAS) as a measure of the individual’s experience of pleasure from social and interpersonal events. The CNV waveform, a putative measure of motivational state, showed the maximum negative magnitude in the early anticipatory (S1) CNV and the late imperative (S2) CNV in the central (CZ) region. The findings show a negative correlation between physical anhedonia and early CNV amplitude in the frontal (FZ) region. There were no significant finding in preparation to make a motor response in late CNV in high schizotypes and anhedonics.
INTRODUCTION

Schizophrenia and Schizotypy

Schizophrenia is a severe and chronic disorder that involves an array of cognitive, behavioral, and emotional impairments (American Psychiatric Association [DSM-5], 2013). Persons with schizophrenia may experience positive and negative symptoms. Positive symptoms entail perceptual hallucinations, delusions, and disorganized speech that are in surplus of normal functioning. Negative symptoms include subdued emotional state or response pattern with examples such as flat affect, anhedonia (diminished emotional expression), and avolition (diminished motivation) (American Psychiatric Association [DSM-5], 2013). In addition, this often-chronic disorder involves severe impairments in occupational and social functioning (American Psychiatric Association [DSM-5], 2013). Reduced drive is associated with social dysfunction, and there seems to be a relationship between cognitive and functional impairment in persons with schizophrenia (American Psychiatric Association [DSM-5], 2013). Individuals with this disorder exhibit varying symptoms (American Psychiatric Association [DSM-5], 2013). These dysfunctions frequently restrict an individual’s ability to live autonomously and carry out daily tasks to completion. In addition, social impairments limit the individual’s gratification in attaining daily affairs. Some researchers view the severe symptoms and dysfunction of schizophrenia as the high end of a continuum of psychosis and dysfunction (Lenzenweger, 2006).
Schizotypy is considered a subclinical manifestation of the same psychotic symptoms identifiable in schizophrenia-spectrum disorders and lies on a continuum (Linscott, Myin-Germeys, van Os, 2009). Schizotypy, as a subclinical expression, is indicative of developmental susceptibility in schizophrenia and spectrum disorders (Chun, Myin-Germeys, & Kwapił, 2013, Kwapił & Barrantes-Vidal, 2012). Schizotypy exhibits positive and negative symptoms that are identified by impairment patterns in social relations, affect, and daily functioning. Positive schizotypy is affiliated with paranoid and psychotic-like symptoms. Negative schizotypy is associated with lack of pleasure in daily life, decreased social contact and increased negative affect (Barrantes-Vidal et al., 2013). Four primary symptoms of schizotypy are identified by Meehl (1962) as: cognitive or associative loosening, interpersonal aversiveness or social fear, anhedonia or lack of pleasure ability, and ambivalence. Recent research has implicated additional criteria such as social withdrawal and flat affect (Chapman, Chapman, & Raulin, 1976), magical ideation, body-image, perceptual aberration distortions and referential thinking (Lenzenweger, 2006). There are similarities between schizotypes with psychotic features and schizophrenia-spectrum individuals, although, non-psychotic schizotypes exhibit dissipated models of the same cognitive, behavioral, and emotional disturbances as seen in schizophrenia (Barrantes-Vidal et al., 2013). In addition, non-psychotic schizotypes are at an elevated risk of developing schizophrenia-spectrum disorders. Considering the stated factors, schizophrenia is conceptualized as the most severe end of the schizotypy continuum (Barrantes-Vidal et al., 2013). “Psychometric schizotypes” are identified by their elevated scores on psychometric questionnaires. Utilizing this population offers invaluable material for research in regards to the central features of schizophrenia as
schizotypes are not exposed to the confounding elements of antipsychotic medications, chronic social deficits, cognitive decline, and frequent hospitalization as are individuals with schizophrenia.

**Cognition in Schizophrenia and Schizotypy**

In addition to positive and negative symptoms, individuals with schizophrenia experience cognitive impairments. The cognitive deficits of schizophrenia are distributed in the following domains: attention, memory, and executive functioning (Braff, 1993; Heinrichs & Zakzanis, 1998; Paulsen et al., 1995). Originally, research in schizophrenia focused on the positive symptoms of hallucinations and delusions and medication effectiveness for treatment. Recent studies have focused on negative symptoms of schizophrenia that include lack of ability to express emotion, experience pleasure, begin new activities, and complete tasks (Earnst & Kring, 1997; Moller, 2007; Salvatore, DiMaggio, & Lysaker, 2007; Tsai, Lysaker, & Vohs, 2010). Due to differences in their etiological foundations, deficits in negative symptoms function differently than positive symptoms (Andreasen et al., 1990; Foussias & Remington, 2010; Tsai et al., 2010; Harvey, Koren, Reichnberg, & Bowie, 2006), resulting in a barrier for establishing treatment (Tsai et al., 2010). This simply denotes that persons with schizophrenia react differently to treatment options due to the heterogeneous characteristics of negative symptoms (Tsai et al., 2010). As a result, research has tried to determine if deficits can be isolated and whether specific deficits have predictive efficacy for treatment and functional status (Tsai et al., 2010). Many studies have linked cognition and functional deficits in persons with schizophrenia (Green, 1996; Niendam et al., 2006). Other studies have questioned the correlation between cognitive deficits and negative symptoms,
suggesting these two variables are independent domains of illness needing separate treatment plans (Harvey et al., 2006).

Numerous studies have implicated impairments in attention as a potential element in certain forms of negative symptoms (Cornblatt & Keilp, 1994; Mcgehie & Chapman, 1961; Tsai et al., 2010). Additionally, the National Institute of Mental Health created a sizable initiative titled Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) to measure and advance outcomes for treatments in cognition in schizophrenia. Siblings and first-degree relatives of individuals with schizophrenia have also exhibited cognitive deficits, implicating the possibility of developing psychosis (Heydebrand, 2006; Schubert & McNeil, 2005). The findings of cognitive impairments in the schizophrenia spectrum can be beneficial for treatment options and predicting future pathology.

**Cognition in Schizotypy: Attention**

Sustained attention refers to the ability to maintain attention to sensory information over a lengthy period of time in order to prepare and maintain alertness for responses (Park et al., 2012). Research has provided mixed results in regards to the cognitive functioning of persons with schizotypy. Studies have persistently shown that schizotypal individuals have attention deficits, in specific, sustained attention. Studies have found that schizotypal individuals show sustained attention measured by the continuous performance task - identical pairs (CPT - IP) (Lenzenweger, Cornblatt, & Putnic, 1991; Roitman et al., 1997). In addition, participants utilize working memory in the CPT - IP task as they respond to a stimulus that matches the previous one (Birkett et al., 2007). Working memory involves using temporary storage to gather information for
complex cognitive tasks such as learning and reasoning. Working memory and sustained attention are both used in the CPT-IP task. Impairments in these areas can impact a person’s comprehension and reaction time to paired stimuli. In addition, elevated random errors on cognitive tasks have been found with schizotypes (Bergida & Lenzenweger, 2006). A study by Lenzenweger (2001) looking at reaction time (RT) performance in relation to sustained-attention, in individuals with schizotypy, found significantly longer RT performance during the CPT-IP tasks. In addition, positive schizotypal symptoms such as perceptual aberrations, ideas of reference, or odd beliefs have shown reduced accuracy during the CPT task (Keefe et al., 1997; Lenzenweger, 2001). Simply stated, reduced reaction time has been often associated with attentional dysfunction. Tsai et al (2010) suggest that negative symptoms such as social withdrawal may stem from impairments in the processing of incoming stimuli, making it difficult to differentiate amongst relevant and irrelevant stimuli. In addition, for individuals with cognitive impairments, this disoriented process makes interpreting and responding to complex social interactions extremely difficult. Overall, cognitive deficits debilitate global functional outcomes such as job performance, social functioning, social problem solving, and social skills achievement (Brekke et al., 1993; Green, 1996; Green et al., 2000b; Hegde et al., 2013; Milev et al., 2005).

**Cognition in Schizotypy: Memory**

Spatial working memory is another domain in which individuals with schizotypy have presented consistent impairments. Working memory refers to a set of mental processes that offer temporary and simultaneous storage and manipulation of information for complicated cognitive tasks such as language comprehension, learning, and reasoning.
Working memory can be divided into three sections: (1) central executive - referring to the allocation of mental resources, controlling the flow of information (2) visuospatial - understanding visual representation and their spatial relationships, and (3) phonological loop - referring to speech and language information attainment (Baddeley, 1992). Simply stated, working memory is an ongoing system where stimuli can be redistributed, coordinated, and carried out. Spatial working memory utilizes occipital (primary visual processing), dorsal parietal (mapping of visual objects into a position), and superior frontal cortex (executive functioning) as means to maintain information for processing stimuli (Awh, & Jonides, 2001). In short, spatial working memory allows for immediate memory retrieval through visual information. This system of spatial memory relies upon implicit eye-movement procedures. Eye-movement procedures, have shown to disrupt the oculomotor systematic maintenance of information (Awh, & Jonides, 2001). In a study (Park, Holzman, & Lenzenweger, 1995) using delayed-response task, spatial working memory was evaluated looking at subjects who scored high on the Perceptual Aberration Scale (Chapman et al., 1976) an indicator of schizotypy. The Perceptual Aberration Scale is a self-report measure of disturbances and distortions in the perception of body image and objects (Chapman et al., 1978). These participants were significantly less precise than controls on the oculomotor delayed response task, which measures spatial working memory (Park et al., 1995). This finding suggest that high schizotypy subjects were not able to maintain the stimuli or given information in working memory.

Cognition in Schizotypy: Executive Functioning
Executive functioning is another domain discussed in schizotypy. Executive functioning refers to a set of mental processes that connect our past experiences with present actions. These activities include thinking and decision-making, planning and problem solving. In addition, executive functioning involves the comprehension of patterns or relationships and the ability to inhibit or modify a previously established pattern. Executive/attentional impairments have been established in both acute psychotic schizophrenic patients and subjects in remission (Asarnow & MacCrimmon, 1978; Cannon et al., 1994; Laurent et al., 2000; Nuechterlein & Dawson, 1984; Saykin et al., 1991; Shedlack et al., 1997; Sweeney et al., 1991) and in individuals with schizotypal features (Harvey et al., 1996; Laurent et al., 2000; Lenzenweger et al., 1991; Lezenweger & Korfine, 1994; Obiols et al., 1993; & Trestman et al., 1995). Studies have utilized the Wisconsin Card Sorting Task (WCST; Heaton, 1981) to test individuals for executive functioning specifically concept formation, abstraction and problem solving skills. Some studies have found significant executive functioning impairment in individuals with schizotypy (Gooding, Kwapil, & Tallent, 1999; Poreh, Ross, & Whitman, 1995; Rain, Sheard, Reynold, & Lencs, 1992; Suhr, 1997; & Voglmaier et al., 1997). One study in specific, found a link between WCST perseverative errors (PE) and concept formation (Laurent et al., 2000). WCST PE measures the ability of the individual to be flexible to make changes when presented with a different stimulus. Concept formation refers to the process of combining a series of expressions that group together to form an idea. Simply stated, the study shows a link between how flexible individuals are when presented with different stimuli in relation to how they view themselves. Yet, other studies have implicated no executive function impairment for schizotypes utilizing the WCST
The above mixed results may indicate the need for additional measures for testing executive function impairments in individuals with schizophrenia and schizotypy.

**Social Cognition in Schizophrenia and Schizotypy**

Social cognition is impaired in persons in the schizophrenia spectrum. Social cognition identifies the mental operations used in social interactions including processes such as perceiving, interpreting, and generating responses to the intentions and behaviors of others (Green et al., 2005). Simply stated, social cognition is a way to understand the relationship between cognition and social behavior or how people think of other people (Green et al., 2005). Social cognitive process are how individuals use inferences about others beliefs and intentions to understand social situations (Green et al., 2005). There are five domains in social cognition, which manifest in schizophrenia in unique ways: emotional processing, Theory of Mind (ToM), social perception, social knowledge, and attributions (Green et al., 2005). Emotional processing refers to forms of perceiving and utilizing emotions (Green et al., 2005). The Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) was developed to evaluate the participant’s ability to perceive, utilize, comprehend and regulate emotions (Mayer, J.D., Salovey, P., & Caruso, D. R., 2004). MSCEIT measures how well individuals solve emotional problems by measuring the individual’s ability for reasoning with emotional information (Mayer et al., 2004). The construct of emotional intelligence (Mayer et al., 2004) involves four components: identifying emotions: identifying emotions seen in faces and pictures; facilitating emotions: measuring the quality of participants evaluation of different emotions in different cognitive tasks and behavior; understanding emotions:
understanding the changes between emotions; and managing emotions: regulation of emotions of oneself and others (Green et al., 2005). Research on emotion perception in individuals with schizophrenia has identified deficits in comparison to non-clinical control groups. Persons with schizophrenia show differences in their ability to recognize negative emotions in contrast to positive emotions (Edwards et al., 2002; Hellewell, & Whittaker, 1998; Kohler, & Brennan, 2004; Mandal et al., 1998; & Penn et al., 2007). Research indicates that individuals with schizophrenia have limited visual scanning abilities, and spend considerably less time investigating appropriate facial features during emotion perception tasks (Green & Phillips, 2004; Penn et al., 2007; Williams et al., 1999).

Theory of mind (ToM) refers to the ability to mentally represent the mental states of others and infer the intentions of oneself and others (Baron-Cohen, 1995; Jahshan & Sergi, 2006). Individuals with schizophrenia exhibit impairments in ToM which may contribute to their deficits in social functioning (Brune, 2005a; Corrigan & Green, 1993; Greig et al., 2004; Jahshan & Sergi, 2006; Penn et al., 2002; Roncone et al., 2002; Toomey et al., 2002). Social awareness, social intelligence, emotion processing, and ToM have become important factors in social cognition (Brekke et al., 2005; Jahshan & Sergi, 2007; Sergi et al., 2006; & Vauth et al., 2004) due to the strong correlation between neurocognition and social functioning in schizophrenia patients (Brekke et al., 2005; Jahshan & Sergi, 2007; Sergi et al., 2006; & Vauth et al., 2004). Studies of emotion recognition in individuals with psychometric schizotypes and individuals with schizotypal personality disorders have exhibited contrasting results. Jahshan and Sergi
(2007), found impairment in social, family, and academic functioning in psychometric schizotypes.

Social perception involves the ability to use social cues to understand the social environment (Green et al., 2005). This domain requires the participants to use social cues to make inferences about the surrounding social environment. Social perception involves the individual’s perception of relationships between people including issues of intimacy, status, mood state and accuracy (Green et al., 2005). Social knowledge or social schema involves the ability to be aware of roles, rules, and goals in a social situation and how to interact in social settings (Green et al., 2005). For example, a person’s knowledge of a teacher’s role in a classroom is shaped by social knowledge. Social knowledge and social perception work closely together, as one’s knowledge of social cues is needed to make inferences about social roles (Green et al., 2005). Attributions refer to explaining positive and negative outcomes of life events, based on the individual’s attribution of their cause (Green et al., 2005). Positive events are seen as accomplishments attributed to the self, in contrast to negative events, which are delegated to others.

As previously stated, social cognition incorporates emotional and cognitive processing. Negative symptoms, such as anhedonia, may include the same emotional processing dysfunctions seen in social cognition (Penn et al., 2008). Studies (Brunet et al., 2003; & Cutting & Murphy, 1990) have shown, although there is a relationship between social cognition, neurocognition, and negative symptoms, they differ significantly (Penn et al., 2008). Anhedonia is viewed as the individual’s reduced lack of ability to experience pleasure (Chan et al., 2012; Harvey et al., 2007) and it is assessed by self-report measures such as the Revised Physical Anhedonia Scale (RPAS) and the
Revised Social Anhedonia Scale (RSAS) developed by Chapman and Chapman (1978). The RPAS measures the individual’s ability to experience pleasure from physical stimuli such as food, sex and settings, and the RSAS measures their experience of pleasure from social and interpersonal events (Chapman and Chapman, 1978). Findings have shown mild to severe anhedonia in persons with schizophrenia during both early and chronic stages of the illness (Chan et al., 2012; Horan et al., 2008). Chan and colleagues (2012) found that individuals with attributes of schizotypal personality disorder (SPD) displayed higher scores on social anhedonia than physical anhedonia in comparison to individuals without SPD. Their finding suggests that individuals in non-clinical samples such as psychometric schizotypes exhibit trait anhedonia.

Social cognition in schizophrenia has been utilized to understand the structure and pattern development of paranoia (Bentall et al., 2001; Garety et al., 1999; & Sergi et al., 2007). In addition, social cognition and neuroscience have used neural substrates such as prediction, reward, and facial recognition to hypothesize the difference between individuals with schizophrenia and control groups (Phillips et al., 2003; Pinkham et al., 2003; & Sergi et al., 2007).

**Electroencephalography**

Studies in schizotypy have produced contradictory results utilizing psychometric measures of neurocognition and social cognition. These measures have been used as means to comprehend the emotional, intellectual and mental deficits of this subclinical population. Another method for measuring the cognitive impairments of schizotypy is electroencephalography (EEG). EEG is a non-invasive procedure that measures and records the electrical impulses activated by variation in the neurons from the cerebral
cortex through electrode placements on the scalp. The possible neurons that create currents in the axon include: action potentials (10 ms or less), and post-synaptic potentials (50-200 ms) (Rowan & Tolunsky, 2003). Long-term depolarization of neurons can be one of the reasons for producing change during an EEG recording (Rowan & Tolunsky, 2003). Depolarization refers to the positively charged ions flowing into axons in the cell-membrane. EEG records the combination of excitatory post-synaptic potential (EPSP), commonly located in the dendrites, and inhibitory post-synaptic potential (IPSP), typically located on the cell body of the neuron (Rowan & Tolunsky, 2003).

The EEG procedure grants researchers the opportunity to observe electrical activities across the surface of the brain and witness cognitive changes measured in microvolts (µV). These microvolts are described in terms of magnitude or amplitudes capturing fluctuations. In addition, the fluctuations are captured as rhythmic sine waves by their frequency per second as hertz (Hz) in different regions of the brain (Rowan & Tolunsky, 2003). The normal range of an EEG voltage frequency spans between 1-70 Hz. These rhythms are further divided into four components: alpha, beta, theta, and delta. The alpha rhythm has a frequency of 8 to 13 Hz, and is associated with the awake yet resting state. This wave reflects the greatest amplitude in the occipital region, with regular dissemination in parietal and posterior temporal regions. Additionally, alpha rhythm is attenuated with eye opening but may return to its amplification strength once the eyes are closed. Alpha rhythm is affiliated with cognitive processes such as the ability to recall memories (Chen, Zou, Meichsner, & Zhao, 2010). Beta activity has a frequency of 14 Hz and above. This wave has a rhythmic characteristic and is present during the waking stage. Stimulating beta activity can enhance emotional stability, and increase attention
(Patrick, 1996). Although, this feature generally represents very little significance. Maximum beta amplitude has been documented in the fronto-central region, and excess of it can hinder the accurate analysis of the EEG. Theta activity has a frequency of 4 to 7 Hz, while it can be found in the waking adult EEG, it is mostly present in the light sleep or extreme relaxation state. Theta activity is mostly observed in the midline and temporal domain (Rowan & Tolunsky, 2003). Lastly, delta activity has a frequency of less than 4 Hz. Delta, as the slowest brainwave, occurs during deep, dreamless sleep.

Event-related potentials (ERPs) are averaged and recurrent changes in electrical impulses in the continuous recording of the EEG. ERPs are time-locked to specific sensory, motor, or cognitive episodes (Donchin, 1984). ERPs are perceived as indications of brain activities that surface in preparation for, or feedback to, distinct internal or external events by the subject (Fabiani, Gratton& Coles, 2000). ERPs are considered as the physical indication of distinct psychological measures. As a result of ERPs elevated temporal resolution, they are equipped in deciphering the changes in information processing around the time of a behavior response, in addition to lack of a response. Subsequently, the focus of utilizing ERPs is on the relationship between cognitive processing and the ERP activity. ERPs encompass three components, each detailing a different information processing requirement. These components also capture specific information processing tasks and the brain activity implicated in the task (Spencer, Dien, & Donchin, 1999). The three ERP components are classified as: (1) amplitude of a (positive or negative) peak in the waveform in µV, (2) latency of the peak ensuing stimulus appearance in ms, (3) the spatial distribution of ERP amplitudes across the scalp (Fabiani et al., 2000).
The contingent negative variation (CNV) is one of the first ERP components to be interpreted. CNV is a slow, surface-negative electrical brain wave commonly contingent of two consecutive stimuli (Tecce, 1972; Walter et al., 1964). The importance of CNV is as a result of its constant measure of the reaction time (RT). There are two components to the RT: (1) a warning or preparatory stimulus (S1), (2) followed by an “imperative” stimulus (S2) as the participant makes a motor response (Tecce, 1972). The CNV has been recorded across the scalp at the Cz vertex with the 10-20 international system for placement of EEG electrodes (Tecce, 1972).

![CNV waveform example.](image)

*Figure 1.* CNV waveform example. This figure illustrates the stimulus response of (S1) Light Flash followed by (S2) Tone. The CNV identified, is the slight negative shift in the baseline of EEG. The Key Press acts as a neutralizer, returning CNV to baseline.

Another important aspect of the CNV is focused on the correlation between the neurophysiological measures to psychological domains. This is best exemplified by Walter and colleagues (1965a; 1964) with the expectancy concept of the CNV. An important psychological measure correlated with CNV changes is the identification of attention (McCallum, 1969; Tecce, & Scheff, 1969; Tecce, 1972). Generally, maximal
CNV amplitude for non-clinical population occurs in about 30 trials, although there has been sufficient data collected between 5 to 8 trials. This sufficient collection is dependent on the participants understanding of the S1, S2 and motor response paradigm. As shown in figure 1, CNV is generated after a key press or a motor response. In order to achieve a clear CNV, a motor response to S2 is necessary. CNV occurs when there is a physical or mental response made to S2 (Tecce, 1972; Walter, 1966a). Essentially, CNV is capturing the decision-making time frame of the subject in regards to the occurrence of S2.

The *ascending limb* (negative-going) CNV latency reaction time has been noted by two authors as approximately 467 millisecond (Robert & Knott, 1970) and 260 milliseconds after S1 (Cohen, 1969). Figure 2 displays the reaction time and the decision-making materialization of CNV wave in subjects. Type A exhibits the subject’s uncertainty about the time of occurrence of S2. Type B is the result of elevated level of certainty in individuals concerning when S2 appears. Shortened S1-S2 combination denotes the most rapid rise time of CNV (McAdam, Knott, & Robert, 1969; Tecce, 1972).

*Figure 2.* Two types of CNV. Type A (Fast CNV), Type B (Slow CNV)
The *descending limb* or abrupt decline of the CNV is noted at 120 millisecond after the “imperative” stimuli (Tecce, 1972; Walter et al., 1964), describing the return of CNV to baseline is referred to as the resolution of CNV. CNV return to baseline can be immediate, slow or inconsistent. In instances of CNV over firing, its charge at baseline becomes positive in polarity, which can cause a sharper waveform. The CNV magnitude is also measured by three distinct approaches. The first approach measures the maximum negative voltage within the S1-S2 interval, in comparison to the EEG baseline before the appearance of S1. This CNV maximum voltage is averaged at 20 μV (Cohen, 1969; Cohen et al., 1967; Jus et al., 1968; Tecce, 1972; Walter, 1967; Walter et al., 1967). Second, is to have a fixed pre-S2 epoch voltage for the CNV as a mean for comparison (McCallum & Walter, 1968b; Tecce, 1972). Lastly, the surface under the CNV has been utilized as micro-volt-second time measure (Low & McSherry, 1968).

The CNV is distributed across the scalp in both the anterior-posterior and lateral axes. Maximal amplitudes are discovered at vertex, with smallest amplitudes in the posterior region of the brain (Tecce, 1972). Modifications of CNV are dependent upon the stimulus condition. These stimulus conditions can include: withdrawal, magnitude of effects, stimulus content, task complication, and inter-stimulus intermissions (Tecce, 1972). While there has been lack of sufficient studies examining the test-retest reliability of CNV time occurrence (Straumanis, Shagass, & Overton, 1969), reliable findings have been noted for CNV amplitude elevation during motor response to S2 (Irwin et al., 1966; Jus et al., 1968; Low et al., 1966; Peters et al., 1970; Small & Small, 1970; Straumanis et al., 1969; Tecce, 1972; Walter et al., 1964). Although, it is imperative to indicate the
occurrence of CNV in the absence of a motor response, in specific when a novel stimulus is presented in S2, or decision making is involved (Gullickson, 1970; Tecce, 1972).

**EEG in Schizophrenia and Schizotypy**

Research utilizes EEG and ERPs in clinical population studies to better comprehend the neurobiological foundations of their abnormalities in perceptual and cognitive processing at a specific time, preceding a stimulus response. EEG is used to measure the control group’s electrical activity in comparison to that of individuals with schizophrenia as means to differentiate between the deviant tones. These assessment tools may identify risk of developing schizophrenia. CNV waveform is affiliated with motivation function or intention to perform, as well as a complex physiological set used for selection or preparation (Low et al., 1968; Tecce, 1972). ERP studies of S2 amplitude in schizophrenia population versus controls (Simlai, Nizamie, & Khess, 2010) have yielded consistent significant results of reduced amplitude in CNV in the clinical patients (MaCallum, 1988; Pritchard, 1986; Simlai et al., 2010; & Wagner et al., 1996;).

Amongst the schizophrenia population, CNV is well documented as having a modified amplitude and topography, and may be seen as a consistent marker for schizophrenia. Similarly, ERP findings in schizophrenia have been significant between psychotic patients and control groups, showing lower amplitude in schizophrenia population. Reduced ERP amplitudes are viewed as cognitive impairments such as information processing, lack of concentration, elevated distractibility or expectancy (Callaway, 1970; Cohen, 1991; & Simlai et al., 2010). The CNV is affiliated with focused attention and may be a predictor of conscious awareness (Simlai et al., 2010). In addition, some
researchers (Maertens et al., 1986; & Marczynsky, 1978; ) have speculated CNV represents dopaminergic characteristics.

Simlai and colleagues (2010) looked at the S2 amplitude of the CNV of schizophrenia patients on medication and drug free in comparison to healthy control participants. The EEG recording consisted of scalp electrodes placed on Fz, Cz, Pz, C3, and C4. The results displayed a significant difference between the schizophrenia patients in comparison to controls in the Cz region, at vertex. In addition, the CNV amplitudes of the schizophrenic patients were smaller than that of the controls in the fronto-central regions, which is associated with executive functioning. The study focused on the impact of medication on the decision making and motor responses in schizophrenic patients in comparison to the control group.

**Research Questions and Expected Findings**

Whereas past studies have examined CNV differences in schizophrenia patients, the present study will examine the relationship between early CNV amplitudes and late CNV amplitudes in persons identified by their levels of schizotypy and anhedonia. It is hypothesized that motivation as measured by the CNV waveform, affects preparation to make responses in high schizotypy and anhedonics. It is hypothesized that high schizotypes and anhedonics will have a problem in anticipatory response in early CNV, showing delayed processing to make a motor response. It is hypothesized that high schizotypes and anhedonics will have a problem making a motor response in late CNV due to their impaired emotion recognition skills.
METHODS

Participants

Subjects were enlisted from the undergraduate subject pool of California State University at Northridge (CSUN). There were 72 participants in the current study. Roughly 1,200 freshmen and sophomore students were screened for schizotypy utilizing the 22-item Schizotypal Personality Questionnaire-Brief Version (SPQ-B; Raine & Benishay, 1995). Based on SPQ-B high scores, possible subjects were approached by telephone to schedule a time and date to participate in the study. Participants who scored a total of 15 or higher or a zero or one were able to participate. Restriction criteria for the participant included: left-handedness, excessive drug or alcohol use, seizures, stroke, severe head injury, or skin or scalp conditions such as psoriasis or hair weaves. In addition, individuals utilizing the following medications were excluded: diet pill, pain medication, anxiolytics, anti-psychotics, and Benadryl. Subjects were informed to abstain from alcohol and drug use 24 hours prior to testing and refrain from drinking caffeine two hours prior to testing. Additionally, participants were informed to enter the study station with their hair and scalp clean and dry, in addition to minimal application of makeup.

Procedure and Measures

All data was gathered in the Neuroscience Laboratory in Monterey Hall at CSUN. Examiners were blind to the subject’s schizotypy and anhedonia scores at the time of testing. Initially, informed consent was obtained before participants were seated for electrode placement. The head of the participants were measured in centimeters from the starting point of nasion to the end point of inion. Electrodes were allocated rendering to
the International 10-20 System of Electrode Placement at the following midline points: Fz, Cz, Pz, and Oz (see Figure 3).

*Figure 3.* Illustration of international 10-20 system for electrode placement

The ground electrode was situated in the middle of the forehead and reference electrodes were attached to each of the earlobes. Vertical (VEOG) and horizontal (HEOG) eye movements were measured using four facial electrodes, placed around the eyebrows, and temple area. In advance of testing, impedance levels were monitored and maintained at or below 15 kΩ at all electrode placements. Electroencephalograph data was recorded using a Neuroscan amplifier and Neuroscan Acquire software 4.0. During electrode placements, participants were asked to fill out the Revised Social Anhedonia Scale (RSAS) (Eckblad et al., 1982). RSAS is a 40-item questionnaire investigating the social dimension of anhedonia, assessing impairments in pleasure seeking from non-physical stimuli such as others, speaking, and expressing emotions with others. In addition, the Revised Physical Anhedonia Scale (RPAS) (Chapman & Chapman, 1978) was administered. RPAS is a 61 item self-report questionnaire, assessing the deficit in
obtaining pleasurable experiences from normally pleasurable physical stimuli such as food, sex, and objects.

Following electrode placement, participants were situated in a comfortable chair approximately two to three feet in front of a computer screen. The testing area was unadulterated of distracting materials and lights were turned off, allowing only natural light to enter the testing location. Each participant was given three distinct continuous performance tasks (CPTs), each lasting approximately 10-12 minutes. Data from the second CPT, a measure of emotion recognition and working memory, was used in the present study. Additionally, the last CPT utilized imagery of facial expressions of emotion, but required a verbal response. Before and after each of the CPT conditions were conducted, the Stanford Sleepiness Scale (Hoddes et al., 1973) was given to assess the participant’s level of sleepiness and alertness. Between each of the three CPT conditions, subjects completed questions from the Social Adjustment Scale-Self-Report (SAS-SR; Weissman et al., 1978). This measure assesses three main domains of social functioning: academic, peer relationships, and family relationships. Questions evaluated performance in these domains across a two week period. Each question on the scale granted up to six possible replies, only one answer was needed.

The CPT Happy Happy Face task consisted of photographs from Ekman and Friesen’s Pictures of Facial Affect set (Ekman & Friesen, 1975). These electronic images were displayed individually on the computer screen for 500 ms with an inter-trial interval of 1600 ms. There were five different emotions displayed as the stimuli: fear, anger, surprise, happiness, and sadness. These images had an equal distribution of gender. The task lasted for a total duration of 10 minutes and included 384 stimuli photographs.
Participants were to press a button with their right index finger when they evaluated the facial expression displayed in a current stimulus as happy and the preceding stimulus was also happy. This presentation of two consecutive happy stimuli is known as the target or Go event. When presented with the target event, participants were to make a button press as quickly and accurately as possible. This target or Go event is the response this study is interested in investigating.

**Statistical Analyses**

A simple regression model was employed in the present study. The comparing groups are schizotypy (high, low), anhedonia (continuous), and CNV lead (FZ, CZ, PZ). The primary outcome measure is CNV amplitude using a regression model. Pearson correlation was used to examine the relationship between main effects of Group and Lead as well as the different contributions of each dependent variable of Group by Lead interaction effect. The independent variables are schizotypy (high, low) and anhedonia (continuous). The dependent variable is identified as: early CNV amplitude with three levels of (FZ, CZ, PZ) and late CNV amplitude with three levels of (FZ, CZ, PZ).
RESULTS

A standard regression model was performed to examine the relationship between schizotypy (high, low), social anhedonia (continuous-centered for regression), physical anhedonia (continuous-centered for regression), interaction of schizotypy and physical anhedonia, interaction of schizotypy and social anhedonia, interaction of physical and social anhedonia and the early CNV amplitude of FZ, CZ, PZ and the late CNV amplitude of FZ, CZ, PZ.

**Early CNV Amplitude of FZ**

The variables schizotypy ($M = .653, SD = .479$), physical anhedonia ($M = 13.06, SD = 6.088$), social anhedonia ($M = 9.58, SD = 6.556$), interaction of schizotypy and physical anhedonia ($M = .075, SD = 4.686$), interaction of schizotypy and social anhedonia ($M = 1.397, SD = 5.534$), interaction of physical and social anhedonia ($M = 9.301, SD = 41.695$) were significant predictors of the early CNV amplitude in FZ, $F (6, 71) = 3.520, p < .05$, accounting for about 25% of variance in early CNV amplitude in FZ. Interaction of schizotypy and physical anhedonia (unstandardized coefficient = .542, $SE = .200, p < .05$, standardized coefficient = .566) and physical anhedonia (unstandardized coefficient = -.496, $SE = .151, p < .05$, standardized coefficient = -.673) were significant predictors of early CNV amplitude in FZ. Correlation analysis found a significant ($p < .05$) negative correlation between physical anhedonia and early CNV amplitude of FZ. This indicates individuals with physical anhedonia exhibited a lower CNV amplitude in FZ. Refer to table 1 for the complete correlation table.

Table 1
Correlation of Early CNV FZ AMP and 6 predictor variables

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*p < .05

Early CNV Amplitude of CZ

The variables schizotypy ($M = .653, SD = .479$), physical anhedonia ($M = 13.06, SD = 6.088$), social anhedonia ($M = 9.58, SD = 6.556$), interaction of schizotypy and physical anhedonia ($M = .075, SD = 4.686$), interaction of schizotypy and social anhedonia ($M = 1.397, SD = 5.534$), interaction of physical and social anhedonia ($M = 9.301, SD = 41.695$) were significant predictors of the early CNV amplitude in CZ, $F (6, 71) = 3.145, p < .05$, accounting for about 23% of variance in early CNV amplitude in CZ. Interaction of schizotypy and physical anhedonia (unstandardized coefficient = .697, $SE = .237, p < .05$, standardized coefficient = .625) and physical anhedonia (unstandardized coefficient = -.610, $SE = .178, p < .05$, standardized coefficient = -.710) were significant predictors of early CNV amplitude in CZ variable. Correlation analysis resulted in a significant ($p < .05$) positive correlation between the interaction of physical and social anhedonia and early CNV amplitude of CZ. This indicates that individuals
with high social and physical anhedonia experience an increase in CNV amplitude in CZ.

Refer to table 2 for the complete correlation table.

Table 2

<table>
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*p < .05

**Early CNV Amplitude of PZ**

The variables schizotypy \( (M = .653, SD = .479) \), physical anhedonia \( (M = 13.06, SD = 6.088) \), social anhedonia \( (M = 9.58, SD = 6.556) \), interaction of schizotypy and physical anhedonia \( (M = .075, SD = 4.686) \), interaction of schizotypy and social anhedonia \( (M = 1.397, SD = 5.534) \), interaction of physical and social anhedonia \( (M = 9.301, SD = 41.695) \) were not significant predictors of the early CNV amplitude in PZ, \( F(6, 71) = 1.458, p > .05 \), and only accounting for about 12% of variance in early CNV amplitude in PZ. Correlation analysis was performed and resulted in a significant \( p < .05 \) positive correlation between the interaction of physical and social anhedonia and early CNV amplitude of PZ. This indicates that individuals with high social and physical
anhedonia show an increase in CNV amplitude in PZ. Refer to table 3 for the complete correlation table.

Table 3
Correlation of Early CNV PZ AMP and 6 predictor variables

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*p < .05

Late CNV Amplitude of FZ

The predictor variables schizotypy ($M = .653, \ SD = .479$), physical anhedonia ($M = 13.06, \ SD = 6.088$), social anhedonia ($M = 9.58, \ SD = 6.556$), interaction of schizotypy and physical anhedonia ($M = .075, \ SD = 4.686$), interaction of schizotypy and social anhedonia ($M = 1.397, \ SD = 5.534$), interaction of physical and social anhedonia ($M = 9.301, \ SD = 41.695$) were not significant predictors of the late CNV amplitude in FZ, $F_{(6, \ 71)} = .951, \ p > .05$, accounting for about 8% of variance in late CNV amplitude in FZ. Physical anhedonia (unstandardized coefficient = .181, $SE = .085, \ p < .05$, standardized coefficient = .484) was the sole significant predictor of late CNV amplitude in FZ variable. Correlation analysis was performed and did not result in a significant ($p > .05$)
correlation between the late CNV amplitude of FZ and the predictor variables. This indicates the predictor variables, exhibited no relationship with the late CNV amplitude in FZ. Refer to table 4 for significant correlations between predictor variables.

Table 4
Correlation of Late CNV FZ AMP and 6 predictor variables

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<td>5.534</td>
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*p < .05

**Late CNV Amplitude of CZ**

The variables schizotypy ($M = .653, SD = .479$), physical anhedonia ($M = 13.06, SD=6.088$), social anhedonia ($M = 9.58, SD = 6.556$), interaction of schizotypy and physical anhedonia ($M = .075, SD = 4.686$), interaction of schizotypy and social anhedonia ($M = 1.397, SD = 5.534$), interaction of physical and social anhedonia ($M = 9.301, SD = 41.695$) were not significant predictors of the late CNV amplitude in CZ, $F (6, 71) = .640, p > .05$, accounting for 6% of variance in late CNV amplitude in CZ. Physical anhedonia (unstandardized coefficient = .195, $SE = .109, p = .078$, standardized coefficient = .410) was marginally significant predictor of late CNV amplitude in CZ.
Correlation analysis was performed and yielded no significant correlation between predictor variables and late CNV amplitude of CZ. This indicates individuals with high schizotypy, high physical and social anhedonia exhibited no relationship between executive functioning deficits and making a motor response. Refer to table 5 for significant correlations between predictor variables.

Table 5
Correlation of Late CNV CZ AMP and 6 predictor variables

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*p< .05

Late CNV Amplitude of PZ

The variables schizotypy ($M = 0.653$, $SD = 0.479$), physical anhedonia ($M = 13.06$, $SD = 6.088$), social anhedonia ($M = 9.58$, $SD = 6.556$), interaction of schizotypy and physical anhedonia ($M = 0.075$, $SD = 4.686$), interaction of schizotypy and social anhedonia ($M = 1.397$, $SD = 5.534$), interaction of physical and social anhedonia ($M = 9.301$, $SD = 41.695$) were not significant predictors of the late CNV amplitude in PZ, $F(6, 71) = 1.175, p > .05$, accounting for 10% of variance in late CNV amplitude in PZ. Physical anhedonia (unstandardized coefficient = 0.214, $SE = 0.090$, $p < .05$, standardized
coefficient = .533) was the only significant predictor of late CNV amplitude in PZ
variable. Correlation analysis was performed and resulted in no significant correlation
between predictor variables and late CNV amplitude of PZ. This indicates that
individuals with high schizotypy, high physical and social anhedonia showed no
relationship between emotion recognition deficits and making a motor response. Refer to
table 6 for significant correlations between predictor variables.

Table 6
Correlation of Late CNV PZ AMP and 6 predictor variable

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<td>6. SCHIZOTYPY_SOCIAL ANHEDONIA</td>
<td>-0.115</td>
<td>.185</td>
<td>.206*</td>
<td>.899*</td>
<td>.263*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>7. PHYSICAL_SOCIAL</td>
<td>-0.041</td>
<td>.038</td>
<td>-0.079</td>
<td>.187</td>
<td>.281*</td>
<td>.187</td>
<td>1.00</td>
</tr>
<tr>
<td>Mean</td>
<td>-6.378</td>
<td>.653</td>
<td>.000</td>
<td>.000</td>
<td>.075</td>
<td>1.397</td>
<td>9.301</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>2.449</td>
<td>.479</td>
<td>6.088</td>
<td>6.556</td>
<td>4.686</td>
<td>5.534</td>
<td>41.695</td>
</tr>
</tbody>
</table>

*p < .05
CNV magnitude measures the maximum negative voltage obtained by CNV between the warning (S1) and imperative (S2) area. CNV magnitudes have been related to motivational states. Higher magnitude is related to higher level of motivation. Graph of CNV magnitude is displayed in graph 1 and 2.

Graph 1
*Early CNV magnitudes*

![Graph 1](image1)

Graph 2
*Late CNV magnitudes*

![Graph 2](image2)
Refer to table 7 for the complete descriptive statistics for predictor variables and dependent variables.

Table 7
Descriptive Statistics of predictor variables and dependent variables.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schizotypy High and Low</td>
<td>72</td>
<td>.653</td>
<td>.479</td>
</tr>
<tr>
<td>Physical Anhedonia</td>
<td>72</td>
<td>13.06</td>
<td>6.088</td>
</tr>
<tr>
<td>Social Anhedonia</td>
<td>72</td>
<td>9.58</td>
<td>6.556</td>
</tr>
<tr>
<td>Early CNV FZ AMP</td>
<td>72</td>
<td>-4.81532</td>
<td>4.482286</td>
</tr>
<tr>
<td>Early CNV CZ AMP</td>
<td>72</td>
<td>-5.7772</td>
<td>5.22841</td>
</tr>
<tr>
<td>Early CNV PZ AMP</td>
<td>72</td>
<td>-4.6681</td>
<td>4.64348</td>
</tr>
<tr>
<td>Late CNV FZ AMP</td>
<td>72</td>
<td>-4.2856</td>
<td>2.27813</td>
</tr>
<tr>
<td>Late CNV CZ AMP</td>
<td>72</td>
<td>-6.5826</td>
<td>2.90168</td>
</tr>
<tr>
<td>Late CNV PZ AMP</td>
<td>72</td>
<td>-6.3776</td>
<td>2.44880</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Refer to table 8 for the frequency of high and low schizotypy variable.

Table 8
Frequency of high and low schizotypy.

<table>
<thead>
<tr>
<th>Schizotypy High and Low</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALID LOW</td>
<td>25</td>
<td>34.7</td>
<td>34.7</td>
<td>34.7</td>
</tr>
<tr>
<td>HIGH</td>
<td>47</td>
<td>65.3</td>
<td>65.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
DISCUSSION

The purpose of the current study was to determine a relationship between schizotypy and anhedonia and early CNV amplitude and late CNV amplitude. In specific, the following relationships were examined: (1) motivation as measured by the CNV waveform in high schizotypyes (2) high schizotypes and anhedonics anticipatory response in early CNV, and (3) high schizotypes and anhedonics preparation to make a motor response in late CNV.

Summary of Findings

Motivation

Previous findings show higher magnitudes of CNV waveform indicate a relationship to an individual’s motivational state. Magnitudes of CNV waveforms are measured as the area between the warning (S1) and imperative (S2) region. Larger magnitudes of CNV signify an extensive amount of force or physical effort that is required by the individual to make a motor response to the imperative (S2) stimulus (Tecce, 1972).

The current study shows the largest magnitude in the central (CZ) region of the CNV waveform. This indicates that individuals with high schizotypy had heightened attention, and were motivated and prepared to make a motor response when presented with the happy face go task. As a result of emotional processing dysfunction seen in this population, heightened attention is most likely due to the need to focus more intensely on emotional features of a face in order to differentiate emotions. Additionally, high schizotypes will need more preparation reaction time to recognize emotions.
Anticipatory Motor Response

As hypothesized, high schizotypes and anhedonics exhibited delayed processing to make a motor response as observed in their anticipatory response in early CNV. The current study shows a significant relationship between the predictor variables of: schizotypes, physical anhedonia, social anhedonia, interaction of schizotypes and physical anhedonia, interaction of schizotypes and social anhedonia, and interaction of physical and social anhedonia, and the dependent variable of early CNV amplitude in the frontal (FZ) region. Physical anhedonia and the interaction of schizotypy and physical anhedonia were significant predictors in the CNV amplitude of the frontal (FZ) region. Physical anhedonia showed a stronger prediction significant between the two variables. This is consistent with our hypothesis that individuals with anhedonia may exhibit difficulty in recognizing emotions that will result in anticipatory response in early CNV. The impairment is shown by the delayed processing to make a motor response when given the stimulus. Physical anhedonics lack the ability to experience pleasure from physical stimuli such as touching, hugging and sex, and these factors can be attributing to their lack of understanding emotions shown on the happy go task. Contrary to our hypothesis, social anhedonia is not a significant predictor of decision making for emotion recognition in the early CNV amplitude of the frontal (FZ) region.

Additionally, it was hypothesized that schizotypyes will have a difficult time preparing to make a decision in early CNV amplitude due to cognitive impairments in decision making, planning and problem solving. Although schizotypy was not a significant predictor, the interaction of schizotypy and physical anhedonia was a significant predictor. This indicates that individuals with high schizotypy and anhedonia exhibit problems
with attention, decision making, and dysfunction in emotion recognition, resulting in slower reaction time to make a response.

Looking at the predictor variables of schizotypy and physical anhedonia in early CNV amplitude of FZ, the direction of predictability differs when the variables are analyzed individually as opposed to when they are considered as an interaction. The interaction of schizotypy and physical anhedonia in early CNV amplitude of FZ suggests that high schizotypes with anhedonia exhibited larger or more negative amplitudes. Larger negative amplitudes, are interpreted as an individual’s ability to have good executive functioning or encompassing good decision making, problem solving and interpretation skills.

This finding is interesting when compared to the negative correlation found between physical anhedonia and early CNV amplitude of FZ. The direction change with physical anhedonia indicates there is a relationship between physical anhedonia and smaller amplitudes or less negative amplitudes in the primary motor cortex of the brain. Decreased amplitudes are interpreted as evidence of the individual’s slow responding to a motor response task (Tecce, 1972). Smaller amplitudes have been established in the clinical population of schizophrenia, relating to slower motor responses. This indicates a relationship between the individual’s reduced ability to experience physical pleasure, and to generate a motor response to an anticipated stimulus when presented with the happy face go task. These results, similar to previous findings (Tecce, 1972), indicate that the individual’s lack of certainty about the time of occurrence of the first response, affects their executive functioning in making a decision about the appearance of the second response. Contrary to the hypothesis, there was no direct correlation between high schizotypes and
problem in anticipatory responding in the early CNV amplitude in the frontal (FZ) region. This finding may be due to our demographics educational capabilities, indicating more high functioning schizotypes.

**Preparation Motor Response**

It was hypothesized that high schizotypes and anhedonics will have a problem in preparation to make a motor response in late CNV due to decreased neural substrates such as prediction, reward and facial recognition. Inconsistent with the hypothesis, current study shows no significance between the high schizotypes and anhedonics in their preparation to make a motor response in late CNV. The two waveforms that address these neural substrates are: (1) the frontal (FZ) region, responsible for primary motor response, and (2) parietal lobe (PZ) responsible for integrating information from various sources to create a picture, and make predictions. This finding may be influenced by the fact that the participants were undergraduates. College students are in an environment that demands concentration on curriculum with expectation to pass tests and classes. However, physical anhedonia was a significant predictor of the late CNV amplitude in the parietal (PZ) region, indicating anhedonics lack of emotional processing can be due to decreased facial recognition, resulting in problems with decision making to a motor response when presented with happy face task.

**Limitations and Implications for Future Research**

While this study facilitates our understanding of the relationship between schizotypy, anhedonia, and early and late CNV amplitude of FZ, CZ, PZ, certain limitations apply. Firstly, a regression model was used. Future research may want to utilize a general linear model of mixed design to better interpret cause of effect for levels
of CNV amplitudes in high schizotypes. Secondly, data was collected using high functioning college students. Future studies may consider collecting data from less functioning adults from community samples. Lastly, early and late CNV magnitudes were analyzed only for schizotypy population due to its availability as a dichotomous variable, future studies may want to look at anhedonia as a dichotomous variable as means to analyze CNV magnitudes and assess motivation in anhedonics.

There are a few implications from the lack of difference found between the high schizotypes and anhedonics in their preparation to make a motor response. The current demographics may contribute to understanding how high schizotypes exhibiting social and cognitive deficits can function in a higher education environment with minor impairments. As an illustration, seemingly high schizotypies who have deficits in negative symptoms, and have trouble connecting to other individuals, may benefit from the college environment in obtaining social skills that will allow them the opportunity to enhance their social relations. In addition, anhedonics may be more inclined to participate in collegiate activities due to access availability. Therefore, both implications can further be studied and explored in future research.
References


*Current Opinion in Psychiatry, 19*, 277-81.


salience on sustained attention performance in schizophrenia. *Schizophrenia Research, 135*, 90-94.


APPENDIX A

Schizotypal Personality Questionnaire - Brief

Please answer each item by circling Y (Yes) or N (No). Answer all items even if unsure of your answer. When you have finished, check over each one to make sure you have answered them all.

Y    N  1. People sometimes find me aloof and distant.
Y    N  2. Have you ever had the sense that some person or force is around you, even though you cannot see anyone?
Y    N  3. People sometimes comment on my unusual mannerisms and habits.
Y    N  4. Are you sometimes sure that other people can tell what you are thinking?
Y    N  5. Have you ever noticed a common event or object that seemed to be a special sign for you?
Y    N  6. Some people think that I am a very bizarre person.
Y    N  7. I feel I have to be on my guard even with friends.
Y    N  8. Some people find me a bit vague and elusive during a conversation.
Y    N  9. Do you often pick up hidden threats or put-downs from what people say or do?
Y    N  10. When shopping, do you get the feeling that other people are taking notice of you?
Y    N  11. I feel very uncomfortable in social situations involving unfamiliar people.
Y    N  12. Have you had experiences with astrology, seeing the future, UFOs, ESP or a sixth sense?
13. I sometimes use words in unusual ways.

14. Have you found that it is best not to let other people know too much about you?

15. I tend to keep in the background on social occasions.

16. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?

17. Do you often have to keep an eye out to stop people from taking advantage of you?

18. Do you feel that you are unable to get "close" to people?

19. I am an odd, unusual person.

20. I find it hard to communicate clearly what I want to say to people.

21. I feel very uneasy talking to people I do not know well.

22. I tend to keep my feelings to myself.
APPENDIX B
Revised Social Anhedonia Scale

Instructions:
Please read each of the statements below and circle True (T) or False (F).

T F 1. Having close friends is not as important as many people say.
T F 2. I attach very little importance to having close friends.
T F 3. I prefer watching television to going out with other people.
T F 4. A car ride is much more enjoyable if someone is with me.
T F 5. I like to make long distance phone calls to friends and relatives.
T F 6. Playing with children is a real chore.
T F 7. I have always enjoyed looking at photographs of friends.
T F 8. Although there are things that I enjoy doing myself, I usually seem to have more fun when I do things with other people.
T F 9. I sometimes become deeply attached to people I spend a lot of time with.
T F 10. People sometimes think that I am shy when I really just want to be left alone.
T F 11. When things are going really good for my close friends, it make me feel good too.
T F 12. When someone close to me is depressed, it brings me down also.
T F 13. My emotional responses seem very different from those of other people.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>F</td>
<td>14. When I am alone, I often resent people telephoning me or knocking on my door.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>15. Just being with friends can make me feel really good.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>16. When things are bothering me, I like to talk to other people about it.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>17. I prefer hobbies and leisure activities that do not involve other people.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>18. It’s fun to sing with other people.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>19. Knowing that I have friends who care about me gives me a sense of security.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>20. When I move to a new city, I feel a strong need to make new friends.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>21. People are usually better off if they stay aloof from emotional involvements with most others.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>22. Although I know I should have affection for certain people, I don’t really feel it.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>23. People often expect me to spend more time talking with them than I would like.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>24. I feel pleased and gratified as I learn more and more about the emotional life of my friends.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>25. When others try to tell me about their problems and hang-ups, I usually listen with interest and attention.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>26. I never had really close friends in high school.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>27. I am usually content to just sit alone, thinking and daydreaming.</td>
</tr>
<tr>
<td>T</td>
<td>F</td>
<td>28. I’m much too independent to really get involved with other people.</td>
</tr>
</tbody>
</table>
T  F  29. There are few things more tiring than to have a long, personal discussion with someone.

T  F  30. It made me sad to see all my high school friends go their separate ways when high school was over.

T  F  31. I have often found it hard to resist talking to a good friend, even when I have other things to do.

T  F  32. Making new friends isn’t worth the energy it takes.

T  F  33. There are things that are more important to me than privacy.

T  F  34. People who try to get to know me better usually give up after awhile.

T  F  35. I could be happy living all alone in a cabin in the woods or mountains.

T  F  36. If given the choice, I would much rather be with others than be alone.

T  F  37. I find that people too often assume that their daily activities and opinions will be interesting to me.

T  F  38. I don’t really feel very close to my friends.

T  F  39. My relationships with other people never get very intense.

T  F  40. In many ways, I prefer the company of pets to the company of people.
APPENDIX C

Examples of Stimuli Images from the Continuous Performance Task (Happy Face Go)

Surprise

Fear

Sadness

Anger

Happiness