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# Examining the Role of Episodic and Semantic Networks in Anhedonia: Applying the Accessibility Model of Emotional Self-report to Psychometrically-defined Schizotypy

Kyle Robert Mitchell

Louisiana State University and Agricultural and Mechanical College, kmitc33@lsu.edu

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EXAMINING THE ROLE OF EPISODIC AND SEMANTIC NETWORKS IN ANHEDONIA:  
APPLYING THE ACCESSIBILITY MODEL OF EMOTIONAL SELF-REPORT TO  
PSYCHOMETRICALLY-DEFINED SCHIZOTYPY

A Thesis

Submitted to the Graduate faculty of  
Louisiana State University  
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by

Kyle Robert Mitchell  
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## ABSTRACT

Individuals with schizophrenia exhibit a range of abnormalities in self-reported non-current experience of pleasure, but uninterrupted current experience of pleasure. Several researchers have sought to address the mechanism of this deficit, yielding useful models of anhedonia. The accessibility model of emotional self-report suggests that deficits in hedonic response are due to differential activation of, and reliance upon, semantic and episodic memory systems. While this model has been proposed as an explanation of the deficits in hedonic response in schizophrenia, it has not been experimentally validated, and it remains to be seen whether the model will hold across the schizophrenia spectrum. The neurodevelopmental model of schizophrenia emphasizes the importance of understanding these deficits in individuals who are prone to psychosis, but may never manifest diagnosable disorder. The current study therefore sought to experimentally test the accessibility model of hedonic deficit in a sample of 92 individuals. Participants performed a task examining memory of emotionally valenced words designed to elicit semantically related emotional information. Overall, schizotypy was unrelated to abnormalities in memory performance in response to semantically congruent information. However, in disorganized schizotypy, semantic bias was a significant partial mediator of the relationship between schizotypy and current affective ratings. This result suggests the presence of abnormalities in semantic networks that contribute to differential current affective ratings to positively valenced stimuli.

## CHAPTER 1. INTRODUCTION

Early theorists noted that the most debilitating symptoms of schizophrenia are those affecting emotional experience. Cardinal among these deficits is anhedonia, or without ('an') pleasure ('hedonia'). Anhedonia is traditionally defined as a significant reduction in the capacity to experience pleasure (Chapman, Chapman, & Raulin, 1976). Despite the fact that theorists have long regarded anhedonia as a chief symptom in schizophrenia, the importance of research on this symptom has recently exposed inconsistencies in the definition and the mechanism of anhedonia in schizophrenia. As a result, a great deal of ambiguity remains. This line of research has made little progress until recently because anhedonia is a complex and multifaceted group of symptoms, not readily definable through a single definition or model, making it difficult to generalize research findings. This is compounded by the fact that research methods have been unequipped to understand the details surrounding the mechanism of anhedonia. However, recent developments in the translational and affective sciences have provided greater conceptual clarity to our understanding of anhedonia across the schizophrenia spectrum. The current study sought to follow this vane by exploring whether semantic and episodic memory use contribute to symptoms of anhedonia in individuals who are putatively prone to experiencing elevated symptoms of psychosis.

A number of concepts warrant discussion and connection within the extant literature as a preface to the current study. First, a conceptual explanation of schizophrenia and key associated symptoms is provided. Particular focus is given to emotional deficits, and more specifically anhedonia, in schizophrenia. Second, select models of anhedonia derived from the affective and translational science literatures are discussed as invaluable to our understanding of anhedonia. Third, the neurodevelopmental model of schizophrenia is described as a useful tool in which to

examine these models of anhedonia in a subclinical sample. Finally, the literature on emotion abnormalities within subclinical samples of individuals with schizotypy will be discussed. Aims, hypotheses, and methodology of the current study will follow this literature review.

## **1.1 Schizophrenia**

Schizophrenia is one of the most debilitating psychiatric disorders known to humankind. It is characterized by a disruption in a wide range of processes related to thought, behavior, and emotion. According to the Diagnostic and Statistical Manual of Mental Disorders – 5<sup>th</sup> Edition (DSM 5), an individual may be diagnosed with schizophrenia if he or she experiences any two or more of the following symptoms for a period of one month or longer: hallucinations, delusions, disorganized speech, disorganized or catatonic behavior, avolition, blunted affect, or anhedonia (American Psychiatric Association, 2013). An array of additional symptoms is associated with schizophrenia, but is insufficient to base diagnosis. These symptoms include a range of affective symptoms. Individuals with schizophrenia also experience a host of neurocognitive and social cognitive deficits, and a range of accompanying neurological “soft” and “hard” signs (Gold & Dickinson, 2013; Ismail, Cantor-Graae, & McNeil, 1998). Taken together, schizophrenia is an extremely complex disorder to understand and treat.

The disruptions in schizophrenia contribute to severe deficits in functioning in individuals with the disorder. Individuals with schizophrenia experience variable outcomes in social functioning, occupational outcomes, and quality of life, among many other outcomes, which are influenced by conditions of onset of the disorder, premorbid functioning, treatment response, and social and environmental factors (Tandon, Nasrallah, & Keshavan, 2009). On average, individuals experience approximately 10-15 years of direct illness (Parks, Svendsen, Singer, & Foti, 2006). This leads to 5.66 million total years of healthy life lost to schizophrenia

(Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). While partial symptom recovery is often achieved, functional recovery is less common (Lieberman & Kopelowicz, 2005). Furthermore, individuals with schizophrenia exhibit a twofold mortality rate over controls (Parks, Svendsen, Singer, & Foti, 2006).

The difficulties associated with schizophrenia present enormous financial and social burden for patients with the disorder, as well as for society at large. Schizophrenia has a lifetime prevalence of roughly 0.3% – 0.7% (American Psychiatric Association, 2013), and is roughly evenly distributed across geographical and cultural lines, though Western cultures often report slightly higher prevalence of the disorder. Typical age of onset of the illness is between 18 and 25 in males and 18 and 35 in females, with an average difference of approximately 1.71 years between onset when comparing men and women (Eranti, MacCabe, Bundy, & Murray, 2013). While the prevalence of schizophrenia is not as high as other psychiatric disorders, the cost associated with treatment of schizophrenia is prohibitive. Treatment costs for schizophrenia total roughly \$62.7 billion annually in the United States alone (Wu et al., 2002). Moreover, schizophrenia is a largely intractable disorder. The World Health Organization named schizophrenia among the most burdensome psychiatric disorders, and more generally, as one of the leading causes of healthy years lost to disease (Murray et al., 2012).

Despite the economic and social tolls that are caused by schizophrenia, the details of its etiology are unknown due in part to the considerable heterogeneity within the disorder. Schizophrenia is associated with winter birth, gestational influenza, low socioeconomic status, adolescent marijuana use, urban living, and a host of genetic risk factors, among other risk factors. Heritability studies suggest that schizophrenia is approximately 50% heritable (Tsuang, 2000). Contrast these findings with findings from large-scale Genome Wide Association Studies



(GWAS), which suggest that no one gene confers a significant risk for the disorder. These molecular genetic studies find that approximately 23% of the variance is accounted for by consistent, identifiable Single Nucleotide Polymorphisms (SNPs – variations in individual structural components of genes; Lee et al., 2012). This pattern of findings is interesting in that it suggests that schizophrenia is a highly polygenic and heritable group of rare genetic abnormalities that converge as a single disorder (Gershon, Alliey-Rodriguez, & Liu, 2011).

Environmental factors may represent another important etiological risk in schizophrenia. Researchers are aware of a number of risk factors including childhood trauma (Morgan & Fisher, 2007) and prenatal developmental insults (Lewis & Levitt, 2002), as well as protective factors including family environment (Schlosser, Pearson, Perez, & Loewy, 2012) for schizophrenia, but no etiology has been discovered that can sufficiently explain the emergence and maintenance of psychotic symptoms. These various risk factors all converge on a diathesis-stress model of schizophrenia, in which an accumulation of underlying risk factors, coupled with the effects of precipitant stressors causes individuals to convert to schizophrenia (Walker & Diforio, 1997). These etiological complexities contribute to significant heterogeneity in the clinical presentation of schizophrenia both between and within individuals, causing difficulties in classifying and understanding the disorder.

## **1.2 Heterogeneity in Schizophrenia**

Schizophrenia is a complex and heterogeneous disorder. This heterogeneity has been evident since the conception of the disorder (Engstrom & Weber, 2005, Meehl, 1962). Researchers have developed several methods to address the problem of heterogeneity in schizophrenia using a variety of methods. In one such method called the statistical model, the symptoms associated with schizophrenia map onto three categories: positive symptoms, negative

symptoms, and disorganized symptoms. These symptoms manifest in varying degrees between individuals (Tandon, Keshavan, & Nasrallah, 2008). Positive symptoms are defined as an addition of symptoms not experienced by the normal population. These include delusions and hallucinations. Negative symptoms are defined as deficits in normal functioning, which include avolition, anhedonia, and blunted affect. Disorganized symptoms are characterized by bizarre speech and behavior, as well as thought disorder. Phenotypic expression in individuals with schizophrenia often varies drastically and there is considerable heterogeneity between individuals with schizophrenia at each unit of analysis, including etiological, biological, and phenotypic factors (Tsuang & Faraone, 1995). This heterogeneity may be a function of genetic (Tandon et al., 2008), neurobiological (Keshavan, Tandon, Boutros, & Nasrallah, 2008), environmental (Tandon et al., 2008), epigenetic (Dempster, Viana, Pidsley, & Mill, 2013), or other yet-unidentified factors. Current research suggests that this heterogeneity results in individual differences in phenotypic expression, treatment response, and overall prognosis (Tandon, Nasrallah, & Keshavan, 2010).

Heterogeneity within individuals with schizophrenia is an unresolved issue that leads to difficulties in understanding and classifying the disorder. Symptomatology often varies within individuals across time, with negative symptoms manifesting prior to the initial psychotic break, followed by a period of positive symptom expression (Yung & McGorry, 1996). Arndt and colleagues conducted a longitudinal assessment on the symptoms of schizophrenia to assess the stability of the various dimensions of symptoms over time. Their findings indicated that negative symptoms are relatively stable across time, while positive and disorganized symptoms are less stable and declined over time (Arndt, Andreasen, Flaum, Miller, & Nopoulos, 1995). Further, these symptom dimensions varied independently of one another, suggesting that it is

inappropriate to characterize them as a unitary construct (Arndt et al., 1995). This heterogeneity complicates treatment and classification, as there is no “prototypical” patient with schizophrenia. While the positive symptoms are treated with relative success through antipsychotic treatment, the negative symptoms, including abnormalities in emotional experience, are much harder to treat and are less well understood than the positive symptoms. Treatment of negative symptoms has remained unsuccessful. However, research on negative symptoms has seen tremendous growth in the past 30 years. This research is justified, as these symptoms contribute to poor prognosis, and a comprehensive understanding these symptoms is essential to a comprehensive understanding of schizophrenia.

### **1.3 Emotional Deficits in Schizophrenia**

Early theorists recognized that individuals with schizophrenia experience a host of emotional abnormalities, but these have only been of significant focus since the 1980s (Andreasen, 1983; Engstrom & Weber, 2005; Kay, Fiszbein, & Opfer, 1987). Despite considerable gains in this venue, these symptoms are poorly understood and remain intractable to current treatments. More recent research has sought to understand the cognitive and psychological correlates of negative symptoms with some success. Researchers have uncovered a number of deficits in emotional expression and experience in individuals with schizophrenia. Chief among these deficits in emotional experience is anhedonia.

Our conceptualization of anhedonia has evolved considerably over time. Anhedonia was originally conceptualized as a diminished capacity to experience pleasure, and was traditionally studied in the context of affective disorders. Following classic theoretical work, researchers have recently begun focusing significant resources towards understanding anhedonia in schizophrenia. However, anhedonia is not as straightforward a construct as originally thought.

Of importance in the issue of anhedonia in schizophrenia is the time course of hedonic response. Deficits in hedonic response are typically examined in the context of evocative studies in which transient emotional experience is measured, or in studies examining global emotional experience. Researchers find nearly universally that individuals with schizophrenia exhibit deficits in global emotional experience but largely normal current emotional experience (Cohen & Minor, 2010; Kring & Elis, 2013). This pattern of deficits in global emotional experience and relative normality in transient emotional experience reveals a dissociation of emotional experience in individuals with schizophrenia. This dissociation has been researched extensively, as it may hold the potential to help understand the nature of anhedonia in schizophrenia. Research has produced a consistent set of findings associated with anhedonia in schizophrenia, but the mechanism is still unclear. However, the dissociation between state and trait emotional experience may hold some promise in clarifying how we view anhedonia in schizophrenia.

#### **1.4 “The Emotion Paradox” in Schizophrenia: The View from the Affective Sciences**

The pattern of results from self-report and emotion induction studies has revealed an apparent discrepancy in emotional experience in schizophrenia. As mentioned above, individuals with schizophrenia report deficits in generalized trait hedonic response, but these deficits are not observed when we examine current, or state hedonic response. Researchers have conceptualized this discrepancy as “the emotion paradox.” These researchers have developed several models to explain the emotion paradox in schizophrenia. Recent translational research in the cognitive and affective sciences literatures holds promise in clarifying our conceptualization of anhedonia in schizophrenia.

One model of deficits in hedonic response posits that time course is an important distinction in characterizing the emotion paradox in anhedonia. This distinction explains the

emotion paradox by discriminating between state and trait pleasure. Trait deficits in pleasure consist of reductions in pleasure that occur when individuals with schizophrenia are asked generally about their experience of pleasure (Cohen, Najolia, Brown, & Minor, 2011). State pleasure deficits are much less common and manifest as reductions in pleasure occurring while directly engaged in a pleasurable experience within the laboratory and throughout daily life experiences (Gard, Kring, & Gard, 2007; Kwapil & Silvia, 2009). This distinction between state and trait anhedonia is supported by evidence suggesting that state and trait pleasure are influenced by distinct neurobiological (and related cognitive) mechanisms (Gorwood, 2008). The state-trait disjunction may represent an important facet in informing our understanding of hedonic response in schizophrenia.

Methodological advancements in the measurement of pleasure have contributed to our understanding of the state-trait emotion paradox in schizophrenia. The assessment of anhedonia has been traditionally circumscribed to self-report measures and clinical interviews in which researchers ask about how individuals generally felt over a temporally distal and nonspecific time range (e.g., Schedule for Negative Symptoms (SANS; Andreasen, 1983; Horan et al., 2006)). Other assessments tap into how individuals would hypothetically feel (e.g., Chapman Physical and Social Anhedonia Scale). Others still examine general trait-like anhedonia and how individuals expect to feel in the future (Temporal Experience of Emotion Scale (TEPS)). These methods of assessing anhedonia access a generalized, trait-like facet of anhedonia reflecting how individuals generally feel about their global emotional experience. Individuals with schizophrenia report disturbances in their experience of pleasure on these trait measures of emotion (Cohen, Najolia, Brown, & Minor, 2011; Llerena, Strauss, & Cohen, 2012). Current research suggests that self-report and clinical interview measures engage a trait-like facet of

pleasure reflecting trait pleasure quite effectively, but do not measure current deficits in pleasure reflecting state pleasure (Strauss & Gold, 2012).

Further temporal resolution is achieved through laboratory-based emotion induction studies in which subjects are presented with emotionally evocative stimuli and are asked to rate their hedonic response in the moment. These studies have allowed researchers to better understand the nature of transient real-time, or state, experience of pleasure (Kring & Caponigro, 2010; Kring & Elis, 2013). Additionally, ecological momentary assessment (EMA) procedures seek to examine emotion in real-time, as they are experienced by subjects outside of the laboratory setting. Gard and colleagues designed an EMA procedure that taps the temporal nature of anhedonia (Gard, Kring, & Gard, 2007). Individuals with schizophrenia reported levels of pleasure similar to controls while they were engaged in pleasurable activities, though when queried about these events prior to their occurrence, individuals with schizophrenia expected to experience less pleasure than controls. These results suggest that individuals with schizophrenia exhibit deficits in trait hedonic response. These individuals, however, exhibit largely normal state-dependent hedonic response. Research by Cohen and Minor (2010) found that while individuals with schizophrenia report emotional abnormalities as soon as seconds after an emotional experience, their “on-line” emotional experience is actually quite similar to that of controls (Cohen & Minor, 2010). This research has elucidated the importance of time course in anhedonia, leading the way towards a model of emotional self-report that conceptualizes deficits in hedonic response as expected variations in response processes based upon time-based factors.

### **1.5 The Accessibility Model of Emotional Self-Report**

The accessibility model of emotional self-report posits that deficits in cognitive functioning contribute to the pattern of abnormalities observed in the emotion paradox (Strauss

& Gold, 2012). Researchers in the affective science literature have recently redefined state and trait anhedonia as current and non-current evaluations of pleasure. This theory suggests that anhedonia may manifest due in part as a result of abnormalities in cognitive functioning, and posits the threshold of which individuals with schizophrenia use semantic and episodic knowledge networks, respectively, as a potential mechanism (Strauss & Gold, 2012). Individuals with schizophrenia may preferentially rely upon global semantic networks when asked about temporally recent events rather than relying upon the more specific episodic network, and thus should exhibit a logical set of responses based upon the network activated by the stimulus.

Higher order cognitive biases exhibited by individuals with schizophrenia may contribute to the aberrant use of semantic and episodic memory systems (Strauss & Gold, 2012). Robinson and Clore (2002) propose that healthy controls exhibit an overestimation bias in which individuals rate both their retrospective and hypothetical future hedonic responses as considerably higher than their ratings of current hedonic response. The overestimation bias is thought to be a component of the semantic knowledge store, and is informed by our situation-specific and identity related beliefs (Robinson & Clore, 2002). It is proposed that individuals with schizophrenia either exhibit a negative bias or lack the more adaptive overestimation bias exhibited by controls, causing them to underestimate (or more accurately estimate) the amount of pleasure they expect to receive in a given situation (Strauss & Gold, 2012). This interaction between the abnormal use of the semantic and episodic memory systems, and a lack of overestimation bias, leads individuals with schizophrenia to report more negative experiences than controls. In a series of studies, Strauss and Gold (2012) found that individuals with schizophrenia were more likely to underestimate their level of positive emotion when the

timeframe for experiencing the emotion in question was temporally distal to the emotional probe (Strauss, 2013a). These abnormalities are not evident when individuals with schizophrenia respond to temporally proximal emotional probes that require responses based on episodic memory networks. This overreliance on a highly generalized semantic network and a lack of overestimation bias may be the mechanism behind the emotion paradox in schizophrenia.

The accessibility model of emotional self-report has been applied to individuals with schizophrenia. Prior studies have examined the accessibility model by eliciting responses to prompts that probe progressively more distal and generalized timeframes in which emotions were experienced. Individuals with schizophrenia reported normal hedonic response in the most proximal and discrete timeframes, but reported fewer positive hedonic responses as the timeframe became more temporally distal and diffuse (Strauss & Gold, 2012). This model exhibits face validity and seems to neatly summarize the emotion paradox. However, work on this model has been largely theoretical. Little research has been done to experimentally manipulate the variables within this model. Further, the theoretical implication behind this theory suggests that semantic and episodic associations interact, but the importance of the semantic system in episodic recall is not highlighted. These propositions are tenuous, and difficult to test in individuals with schizophrenia. However, schizotypy is a model in which to examine the accessibility model of emotional self-report free from some of the above conceptual and methodological restraints.

## **1.6 Neurodevelopmental Models of Schizophrenia and Schizotypy**

Current etiological models of schizophrenia suggest that pathology exists on a continuum across the population (Meehl, 1962, 1990). This suggests that individuals within the population exhibit negative, positive, or disorganized symptoms, or any combination of these symptoms, at



subclinical levels. One such theoretical model proposed by Paul Meehl has been particularly influential. Meehl's theory posits that this genetic factor, termed the "schizogene," contributes to a central nervous system (CNS) anomaly called schizotaxia. This line of research posits that latent liability for schizophrenia is largely genetic. Schizotaxia is characterized by slippage of cognitive associations, which causes an aberration of some control system present at the synaptic level across the entire brain (Meehl, 1990). This aberration causes a host of symptoms that are attenuated from the positive, negative, and disorganized symptoms experienced by individuals with schizophrenia. These subclinical symptoms include ambivalence, social fear, blunted affect, perceptual aberrations, and anhedonia, among many others (Meehl, 1990).

Individuals with schizotaxia exhibit a number of social, cognitive, and basic perceptual abnormalities similar to, but attenuated from those experienced by individuals with schizophrenia. The presence of these abnormalities precipitates behaviors that are then reinforced through social learning principles, which potentiate the abnormal interpersonal and perceptual experiences exhibited by individuals with schizotaxia. This gene by environment interaction leads to the development of schizotypy. Schizotypy is precipitated by the presence of schizotaxia, combined with the social learning influences that are associated with schizotaxia. Meehl went on to say that not all individuals with schizotaxia also develop schizotypy. Meehl's model posits that schizotaxia, and by extension, schizotypy, is a monogenic disorder with an incidence of roughly 10% (Meehl, 1990). While many individuals with schizotypy never go on to convert to schizophrenia, approximately 10% do convert to clinically relevant symptoms of schizophrenia. Individuals with schizotypy exhibit an increased genetic and environmental risk for schizophrenia. With sufficient stressors, or second hits, it is possible for an individual with schizotypy to convert to schizophrenia. These second hits include acute environmental stressors

(joblessness, divorce), stressors or trauma in childhood (witnessing violent crime, poverty), and developmental and prenatal insults (older paternal age, gestational influenza; Walker, Kestler, Bollini, & Hochman, 2004).

### **1.7 Heterogeneity in Schizotypy**

The symptoms associated with schizotypy exhibit heterogeneity that is comparable to the heterogeneity of symptoms expressed by individuals with schizophrenia. As in schizophrenia, the clinical model can be applied to individuals with schizotypy to reduce the variance in measurement of schizotypy. Individuals with schizotypy may endorse positive, negative, or disorganized symptoms, respectively, that are attenuated from symptoms endorsed by individuals with schizophrenia (Kwapil, Barrantes-Vidal, & Silvia, 2008; Raine, 1991). Moreover, specific deficits in emotional experience vary across the respective schizotypy facets (Martin, Becker, Cicero, Docherty, & Kerns, 2011). Individuals with schizotypy exhibit a number of similarities in cognitive, emotional, and behavioral symptoms attenuated from individuals with schizophrenia, making schizotypy a useful research model for understanding the deficits in schizophrenia.

### **1.8 Emotion Deficits in Schizotypy**

While anhedonia is strongly expressed in many individuals with disorders like schizophrenia, these symptoms manifest with varying degrees of intensity in individuals who are putatively at risk for psychotic disorders, as well (Chapman, Edell, & Chapman, 1980). The neurodevelopmental model implicates genetic and social learning risk for the expression of these symptoms. Anhedonia has been found to be an endophenotypic marker of psychotic disorders, suggesting that those who exhibit these subclinical symptoms may be at an increased risk for psychosis. There is genetic evidence to support this endophenotype hypothesis (Chen &

Faraone, 2000; Jonas & Markon, 2014). Individuals with schizotypy who are elevated in anhedonia are at greater risk of developing a schizophrenia-spectrum disorder (Kwapil, 1998). While anhedonia has been assessed in schizotypy using a range of methods that are similar to the methods used in individuals with schizophrenia, researchers have only just begun conceptualizing schizotypy as a distinct construct that may hold greater understanding of the various complexities of state and trait anhedonia (Cohen, Mitchell, Beck, & Hicks, 2014).

Individuals with schizotypy report emotional abnormalities that are distinct from, and not wholly explicable when compared with, the deficits exhibited by individuals with schizophrenia. Similar to individuals with schizophrenia, individuals with schizotypy express deficits in trait hedonic response. However, whereas individuals with schizophrenia exhibit dysfunction in trait hedonic response, but no deficits in current state hedonic response, individuals with schizotypy report both diminished current state and global trait hedonic responses (Cohen et al., 2014). This pattern of findings is unexpected, as individuals with schizophrenia generally experience more severe deficits than individuals who are putatively at risk for psychosis across a wide range of symptoms. This line of research has been instructive in pointing out the pattern of deficits in schizotypy, but further research over the nature of these deficits using translational and affective sciences, as has been applied to individuals with schizophrenia, may help to clarify this pattern of deficits.

### **1.9 Affective Science in Schizotypy**

The affective and translational sciences have recently sought to understand the emotional deficits in individuals with schizotypy. The same principles and methods of discriminating between state and trait hedonic experience that have been applied to individuals with schizophrenia have been applied to individuals with schizotypy in order to further explore the

development of hedonic deficits across the schizophrenia spectrum. This is a burgeoning line of research with important implications for how we understand the changes in emotional experience as an individual progresses along the schizophrenia spectrum from high risk to prodrome, to ultimate conversion to schizophrenia. The relative dearth of research into understanding the mechanism behind anhedonia in schizotypy is notable in that understanding this discrepancy between hedonic deficits in individuals with schizophrenia and schizotypy may be instructive in understanding the mechanism behind deficits in hedonic response more generally.

No theory has been aimed at a unified understanding the hedonic deficits in both schizophrenia and schizotypy. Findings from prior research would suggest that individuals with schizotypy will evidence deficits in both state and trait pleasure (Cohen, Callaway, Najolia, Larsen, & Strauss, 2012; Gooding & Pflum, 2012). A recent EMA study examining emotional responses in an ecologically valid experience sampling paradigm reported increased negative affect and decreased positive affect in negative schizotypy (Kwapil & Brown, 2012). Further, individuals with schizotypy report higher negative affect and lower positive affect in mood induction paradigms (Najolia, Cohen, & Minor, 2011). While these studies are valuable in examining current hedonic response, they do not address the mechanism behind this deficit.

### **1.10 Applying the Accessibility Model to Schizotypy**

The accessibility model of emotional self-report has been valuable in our understanding of hedonic deficits in individuals with schizophrenia, but has not yet been applied to our understanding of the deficits in hedonic response exhibited by individuals with schizotypy. Individuals with schizophrenia exhibit a range of cognitive deficits, including deficits in working memory capacity (Barch, 2005; Dickinson, Iannone, Wilk, & Gold, 2004) and verbal memory (Green, Kern, Braff, & Mintz, 2000). The accessibility model of emotional self-report predicts

that individuals with schizophrenia will rely preferentially upon semantic networks rather than episodic networks in order to compensate for working memory deficits (Strauss & Gold, 2012). Coupled with a lack of a semantic overestimation bias that predicts recognition of negative information, individuals with schizophrenia are expected to recognize more globally negative information in the absence of more temporally proximal episodic information. In other words, deficits are expected in response to temporally distal emotional stimuli (subsumed within noncurrent emotional self-report) but no deficits are expected when reporting on temporally proximal stimuli (subsumed within current emotional self-report). Findings of working memory deficits in individuals with schizotypy, however, are mixed (Chun, Minor, & Cohen, 2013; but see Kerns & Becker, 2008). Moreover, when deficits are exhibited, individuals with schizotypy do not evidence deficits in semantic or episodic memory on the order of magnitude exhibited by individuals with schizophrenia (Sacks, Weisman de Mamani, & Garcia, 2012; Chun et al., 2013). Finally, individuals with schizotypy do appear to exhibit negativistic biases (Kohler et al., 2003), but it is not yet understood whether individuals with schizotypy lack the healthy overestimation bias, as do individuals with schizophrenia. Therefore, the accessibility model of emotional self-report would predict that individuals with schizotypy would not evidence this pattern of recollection of negative information in the absence of more temporally proximal episodic information. These expected findings are discrepant from the pattern of results found in individuals with schizophrenia in that individuals with schizotypy evidence deficits in both state and trait hedonic response. This would suggest abnormalities in both semantic and episodic memory networks or in a differential pattern of semantic memory abnormalities.

Prior research examining the accessibility model is incapable of identifying the mechanism behind anhedonia across the schizophrenia spectrum. Current paradigms utilize

emotional self-report, in which subjects are asked to report their emotions at varying lengths of time—from the most proximal to the most distal emotions. The rationale behind this paradigm is that individuals will use their knowledge of current emotion (including experiential knowledge of current emotion or episodic memory of the most proximal evocative events) in response to proximal emotional stimuli, while semantic memory will be preserved. Conversely, individuals should employ semantic memory systems in response to more distal emotional stimuli. This pattern of results would support prior results of intact online hedonic experience activated by the episodic memory system, but dysfunction in response to hedonic experience activated by the semantic memory system. The expected results are found in schizophrenia, but little research exists on the manipulation of these memory systems.

Application of the accessibility model to the emotion paradox through self-report is instructive, but it is difficult to disentangle the effects of semantic associations on episodic memory. Even when queried about a relatively recent episodic memory, the effect of semantic associations can interfere with the autobiographical memory system (Tulving, 1972). Prior research points to the relationship between semantic associations and episodic retrieval. For example, if a subject is questioned about how a recent job interview has gone, the subject must activate on some level, a semantic representation of a prototypical “good interview” for which to compare their recent experience. It is difficult to disentangle the influence of semantic associations on our episodic memory functioning because these systems so closely interact to create a seamless experience of memory.

While self-reporting on increasingly proximal queries is sufficient for healthy controls, it is not suited for individuals with schizophrenia or schizotypy. It is difficult to parse the contribution of semantic associations on current episodic associations without the control

afforded by laboratory manipulation. Individuals on the schizophrenia spectrum often exhibit a host of cognitive biases that are associated with deficits in response to social and emotional stimuli. Without the capability of laboratory manipulation, these biases may be impossible to separate. In order to fully understand the mechanisms behind anhedonia, it is important to parse these biases from the deficits in cognitive functioning. There is reason to believe that these deficits produce profound abnormalities in the responses of individuals who exhibit them. Conversely, perhaps the deficits in non-current emotion should not be attributed to impairment in semantic processing, *per se*, but can be better explained by the way in which those associations influence more proximal affective episodes, thus causing individuals to form aberrant associations with the pleasurable experience in the moment. Alternative methods and conceptual considerations are warranted in order to produce the discrimination necessary for examining the mechanism of this abnormality.

### **1.11 Depression: a potential confound in measuring anhedonia**

Anhedonia is a heterogeneous construct that manifests in both schizophrenia-spectrum disorders and affective disorders. However, anhedonia presents in individuals with schizophrenia-spectrum disorders differently than in depressive disorders. While individuals with schizophrenia-spectrum disorders exhibit deficits primarily in trait experiences of pleasure (as well as in state experience of pleasure in schizotypy), individuals with depressive disorders exhibit deficits primarily in state experience of pleasure (Bylsma, 2008).

### **1.12 Current study**

Current understanding of anhedonia suggests that individuals with schizophrenia exhibit current consummatory pleasure comparable to controls, while deficits seem to center around trait, rather than state pleasure. Interestingly, individuals with schizotypy appear to exhibit

deficits in both state and trait experience of pleasure. Several researchers have sought to address the mechanism of the trait hedonic deficit in schizophrenia. This has yielded several useful models of anhedonia in schizophrenia including the accessibility model of emotional self-report. This model is effective in explaining the pattern of responses in individuals with schizophrenia, but does not follow the observed patterns of deficits in schizotypy. The current study sought to examine the utility of the accessibility model of emotional self-report in schizotypy by examining the relationship between episodic and semantic memory as related to state and trait hedonic responses.

The accessibility model of emotional self-report is a promising model of anhedonia across the schizophrenia spectrum, but has not yet been examined using appropriate research paradigms. This model proposes that abnormalities in the relationship between semantic and episodic memory systems, as well as a deficient overestimation bias, are important in understanding the dissociation between state (current) and trait (non-current) hedonic response (Strauss & Gold, 2012). However, these systems have not yet been experimentally manipulated to disentangle the role of semantic and episodic memory abnormalities, respectively, in hedonic response. Current measures of anhedonia tap a wide variety of constructs involving self-reported pleasure and reward processing, but experimental paradigms have not directly addressed the role of semantic and episodic memory systems in anhedonia. The current study fills this gap by employing a modified false memory task to assess the reliance on episodic and semantic memory systems in recognition of affectively valenced stimuli. By examining memory of affective stimuli that originate in the laboratory, we were able to more clearly examine the memory systems of interest free from the influence of previously formed semantic associations.



In the current study, we sought to test individuals on a modified version of a well-established episodic memory task, while simultaneously engaging semantic associations. Prior research suggests that reliance on semantic associations can introduce interference, leading to intrusions in episodic memory (Roediger & McDermott, 1995). We sought to engage the semantic network and introduce interference by manipulating affectively congruent or incongruent stimuli during both encoding and recognition by exposing subjects to semantically related affective information and altering semantically unrelated information during recognition in order to examine performance on the memory task.

### **1.13 Aims**

Prior research has yielded results that consistently confirm the presence of state anhedonia in individuals with schizotypy (Cohen et al., 2012, 2011, 2014). However, it is of value to examine state hedonic response in individuals with schizotypy to further confirm these findings. These findings are of particular value in that individuals with schizotypy evidence more extreme dysfunction than do individuals with schizophrenia, which may signify an important area of inquiry in understanding the range of emotional deficits across the schizophrenia spectrum. The first aim of the current study was to replicate prior findings of state anhedonia in schizotypy. Therefore, it was hypothesized that state anhedonia will be significantly related to schizotypy.

Current models from the affective science literature suggest that overreliance on semantic memory systems and a reduced overestimation bias contribute to the deficits in emotional experience in schizophrenia (Strauss & Gold, 2012). Previous research has examined neurocognitive functioning more generally in individuals with schizotypy. However, current research has not examined these abnormalities in semantic versus episodic memory systems in

response to affective stimuli in individuals with schizotypy. The second aim of the current study was to examine the extent to which abnormalities in semantic versus episodic memory are related to schizotypy. It was hypothesized that abnormalities in semantic memory would be significantly related to schizotypy.

Researchers have examined anhedonia in schizotypy using chiefly self-report measures. This has led to a consistent finding of anhedonia in schizotypy. The state-trait disjunction has proven a valuable distinction for understanding the mechanism behind anhedonia, but more sophisticated models of anhedonia in schizophrenia would suggest that a combination of higher order biases and lower order memory functions may explain the pattern of findings in hedonic response. The third, and central aim of the current study, then, was to examine the mediating role of abnormalities in semantic memory on the relationship between self-reported state anhedonia and schizotypy. It was hypothesized that state anhedonia would be significantly related to abnormalities in semantic memory use. Further, it was hypothesized that abnormalities in semantic memory use would mediate the effect of state anhedonia on schizotypy.

Anhedonia is a complicated set of symptoms that is present in many disorders. Parsing the effects of depressive symptoms and other confounding variables is therefore important in drawing conclusions about anhedonia in schizotypy. The current study examined depression and other confounding factors in order to determine whether these affect the relationship between abnormal semantic associations and anhedonia. It was therefore hypothesized that depressive symptoms, and other potentially confounding factors, would be unrelated to abnormalities in semantic memory use such that the above effects would hold even after controlling for these variables.

## CHAPTER 2. METHOD

### 2.1 Participants

Participants consisted of 92 individuals from the Louisiana State University Subject Pool. Participants participated in the current study for partial fulfillment of a research assignment in an undergraduate psychology participant pool. Participants were administered an online version of a modified Likert-scale Schizotypal Personality Questionnaire (SPQ) as a screening measure to ensure that a sufficient sample of individuals who were elevated on schizotypal traits participated in the full laboratory battery. In line with many researchers, we conceptualized schizotypy as a dimensional, rather than taxonic construct (Rawlings, Williams, Haslam, & Claridge, 2008), and therefore analyzed these data using hierarchical multiple linear regression, obviating the need for an extreme-groups design. Individuals who were of interest based upon his or her screening scores were invited to the lab to participate in more in-depth experimentation.

### 2.2 Measures

**2.2.1 Symptoms of schizotypy.** Schizotypal Personality Questionnaire-Brief Revised. The Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR) was administered to individuals as a preliminary screening measure. The SPQ and revised versions of the measure are widely used psychometric indicators of schizophrenia-spectrum disorders (see Lipp, Arnold & Siddle, 1994; Cohen, Matthews, Najolia, & Brown, 2010). The SPQ-BR is a 34-item measure with items taken from the larger 74-item SPQ. The SPQ-BR exhibits acceptable convergent and divergent validity with other measures of psychosis-proneness (Najolia et al., 2011). The SPQ-BR employs a 5-point Likert scale with scores ranging from 0 (strongly disagree) to 4 (strongly agree) on each item. The Likert version of the SPQ-BR has been shown to correlate highly with, and to exhibit greater internal reliability (Chronbach  $\alpha > 0.70$ ) than the dichotomous version of

the instrument (Cohen, Matthews, Najolia, & Brown, 2010). The SPQ-BR was used in the current study to indicate elevated levels of positive, negative, and disorganized schizotypy, respectively.

**2.2.2 Global Psychological Symptom Severity.** Brief Symptom Inventory. The Brief Symptom Inventory (BSI) is a widely used, brief 53-item self-report measure that assesses 9 separate symptom categories (Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, Psychoticism), as well as 3 global distress scales. Responses are made using a 5-point Likert scale ranging from 0 (not at all) – 4 (extremely) in reference to the past week. The scales of the BSI exhibit good reliability (Chronbach  $\alpha$  for each separate scale range between 0.71 and 0.85) and validity (convergent/divergent validity ranging between  $r = 0.33$  and 0.72 with MMPI scales; Derogatis & Melisaratos, 1983). For the current study, we were interested in overall symptom severity at the time of participation, with particular interest in depression severity. Thus the BSI was administered during the laboratory phase.

**2.2.3 Trait Anhedonia.** Chapman Scales for Physical and Social Anhedonia. The Chapman Scales for Physical (CPAS) and Social Anhedonia (CSAS) were used to rate subjects' self-report ratings of physical and social anhedonia (Chapman et al., 1976). The CPAS and CSAS, respectively, exhibit acceptable reliability (Chronbach  $\alpha = 0.66 - 0.80$ ). The scale consists of 88 items: 40 items measuring physical anhedonia, and 48 items measuring social anhedonia in the context of the pleasure that respondents would hypothetically experience in response to various experiences. The CPAS and CSAS were used to measure hypothetical emotion, or emotions that subjects would theoretically experience in a given scenario.

**2.2.4 Current Affective Ratings.** State anhedonia was assessed after presentation of each group of affectively valenced stimuli. These ratings were prompted by asking the participant “How positive do you feel?” This method of assessment was an efficient means of measuring current affective response, and has been shown to produce accurate responses in the moment. Our laboratory has successfully utilized this method of assessment of state affect in prior studies (i.e., Cohen et al., 2012; Cohen & Hong, 2011; Cohen, Hong, & Guevara, 2010) and found consistent significant differences as a function of affective condition. Participants rated their current affective state using a Likert scale of 1 to 9, with 1 being least positive and 9 being most positive (see figure 1). Accompanying this scale were positive and negative Self Assessment Mannequin faces (SAM; Bradley & Lang, 1994). This method was utilized in the current study because we were interested in how participants felt after being exposed to a set of affectively valenced stimuli.

## **2.3 Procedure**

**2.3.1 Screening.** Overall, a total of 722 participants completed our initial online survey. Of these 722 participants, a total of 92 participants completed the lab portion of the study. Of these 92 participants, 67 individuals from the general subject pool were given access to several openings to participate in a larger study of “Speech Characteristics and Mental Health”. Additionally, 25 of the participants with extreme scores ( $\geq 1$  standard deviation above the mean) on the SPQ-BR were invited via email to participate in a larger laboratory-based battery for additional participation points and the possibility of winning a monetary prize.

**2.3.2 Laboratory Phase.** Subjects completed the encoding phase of the affective episodic memory task followed by an affective rating task in which subjects were asked to rate their affective valence after each vignette. Following the affective rating task, individuals

completed the recognition phase of the affective episodic memory task. Together, these tasks required approximately 20 minutes to complete. Subjects completed the aforementioned self-report measures after completing the affective episodic memory and affective rating tasks.

**2.3.2.1 Affective episodic memory task.** An affective episodic memory task was adapted from the false memory literature established by Deese (1959), and expanded upon by Roediger and McDermott (1995). This literature includes a set of tasks designed to examine semantic associations and their effect on episodic recognition. A modified version of this paradigm was chosen for the current study because the original paradigm was used as evidence of the effects of semantic interference with episodic information. This paradigm was well suited for the current study because we expected that individuals with schizotypy would exhibit abnormal reliance on semantic associations to inform memory. This category of memory tasks is frequently used to illustrate semantic interference on episodic memory. Therefore, we reasoned increasing levels of schizotypy would be associated with differential performance on the affective memory task.

The current study imposed a few methodological changes to the false memory paradigm. First, prior research has recently begun to use reaction time as a measure of performance on these tasks (Greve, van Rossum, & Donaldson, 2007) and has thus examined semantic interference through latency of response. Given the relative functioning level of individuals with schizotypy, reaction time provided a measure of performance that was theoretically more sensitive to the bias that we expected to observe with increasing levels of schizotypy. Traditional false memory paradigms present subjects with a list of semantically congruent words and examine whether subjects recalled being presented a novel word that is semantically congruent with the words that were presented. The current study presented subjects with

semantically congruent and semantically incongruent words during the encoding phase, as well as targets and semantically related lures during the recognition phase. This methodological alteration was designed to examine the relative strength of episodic associations, rather than inferring the absence of episodic associations from the semantic associations only. Finally, because this was a study of recognition of affective valence, the current study included a manipulation of valence in which the stimuli were grouped by positive, negative, and neutral valence in order to elicit current affective ratings.

**2.3.2.1.1 Encoding phase.** Subjects were seated in front of a personal computer screen where a sequence of affectively normed words was displayed in pseudorandom order using E-Prime 2.0. Prior to beginning the task, subjects were told that they would be presented with a sequence of words, and that they would be asked to recognize as many of the words as possible without regard to order. The words were then presented according to semantically and affectively congruent groups (see figure 1).

**2.3.2.1.1.1 Stimuli.** A set of normed words selected by valence from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) was displayed sequentially on a computer monitor. The ANEW stimuli have been rated between 1 and 9 for valence, arousal, and dominance in the in the English language with 1 being the lowest and 9 being the highest (see Appendix B for a list of words used). In order to condense previous versions of semantic memory paradigms, 3 word groups, composed of 12 words each were randomly presented to subjects (1 negative, 1 positive, and 1 neutral word group; Roediger & McDermott, 1995). Each word was presented in white 12-point font on a black background for 1000 milliseconds each, with an interstimulus interval (ISI) of 1500 milliseconds. Each sequence of words was arranged semantically and affectively. These word groups were designed to elicit either positive or

negative affect of a given intensity, as determined by previous norm referencing from the ANEW database (Bradley & Lang, 1999).

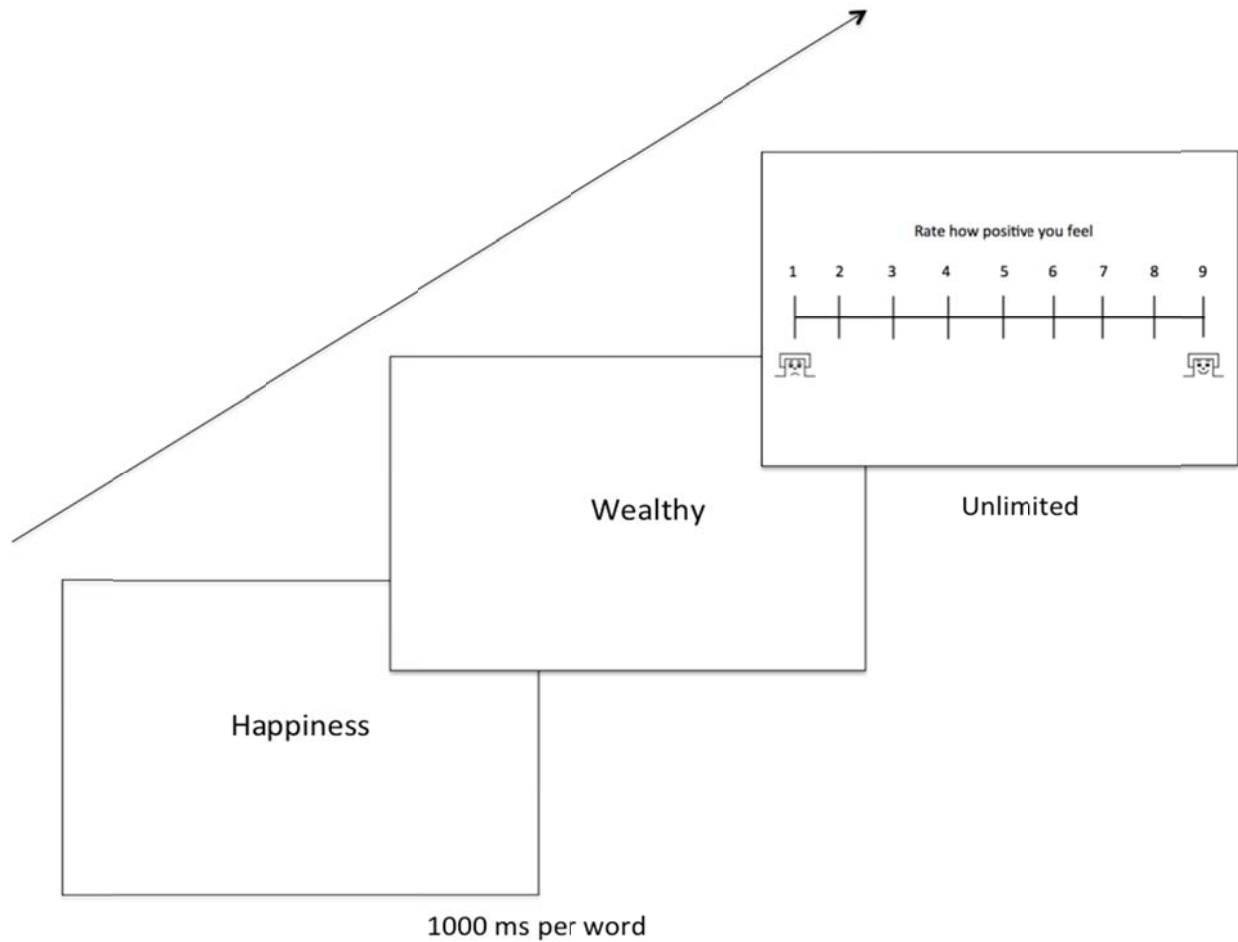


Figure 1. Schematic of encoding phase and assessment of current affect from the affective memory task

Contained within each word group were a series of 9 semantically congruent words that make up a cohesive semantic theme of a particular affective valence of the word group and 3 semantically incongruent words that were incongruent with the affective valence or semantic theme of the word group. The negative word group was designed to elicit an affect rating of approximately 2 and an arousal rating of approximately 7. The neutral word group was designed to elicit an affect rating of approximately 5 and an arousal rating of approximately 4. The positive word group was designed to elicit an affect rating of approximately 8 and an arousal rating of



approximately 7. After each word group is presented, subjects was asked to rate how they felt on the same 1-9 scale. Contained within each word group were a series of 9 semantically congruent words that make up a cohesive semantic theme of a particular affective valence of the word group and 3 semantically incongruent words that were incongruent with the affective valence or semantic theme of therd group. The negative word group was designed to elicit an affect rating of approximately 2 and an arousal rating of approximately 7. The neutral word group was designed to elicit an affect rating of approximately 5 and an arousal rating of approximately 4. The positive word group was designed to elicit an affect rating of approximately 8 and an arousal rating of approximately 7. After each word group is presented, subjects was asked to rate how they felt on the same 1-9 scale.

**2.3.2.1.2 Recognition Phase.** Following the encoding phase, subjects were presented a single list of 36 pseudorandomly presented words (18 words that were previously presented and 18 novel words; see figure 2). Contained within the list were:

- Semantically congruent targets – 6 target words that appeared in, and were congruent with the semantic theme of the previously presented word group. We posited that these targets should be recognized with episodic memory, but may be facilitated by semantic associations because of the congruent nature of the stimuli presentation.
- Semantically incongruent targets – 12 target words that appeared in the word groups, but were not congruent with the semantic theme of the previously presented word groups. We posited that these targets should engage the episodic memory system, as they were not semantically congruent with the theme in the word group and thus should not have been influenced by semantic associations. Participants would need to recognize the specific

exposure to these targets and were not able to infer them based upon the semantic theme of the word group.

- Semantically congruent lures – 6 non-target words that were semantically congruent with the previously presented affective word groups. These lures were hypothesized to engage the semantic memory system, as they were semantically congruent with the theme of the word group and thus should be influenced by the semantic memory system.
- Semantically incongruent lures – 12 unrelated non-target words. We posited that these lures would activate the episodic memory system, as they were semantically unrelated to the targets presented during the encoding phase. Participants would need to compare these words to rule out these lures from the encoding phase. Accordingly, we posited that no semantic knowledge would be necessary or helpful in identifying whether these lures were present during the encoding phase.

Participants were asked to make a speeded yes/no decision as to whether each word was familiar or not. Directly following this yes/no decision, subjects were asked to rate their certainty of the familiarity of each word presented using a serial response box. Subjects were instructed to press the “4” key if the word was definitely present during the encoding phase, press the “3” key if the word was probably present during the encoding phase, press the “2” key if the word was probably not present during the encoding phase, and press the “1” key if the word was definitely not present in the encoding phase. Reaction time and accuracy data were collected for all responses.

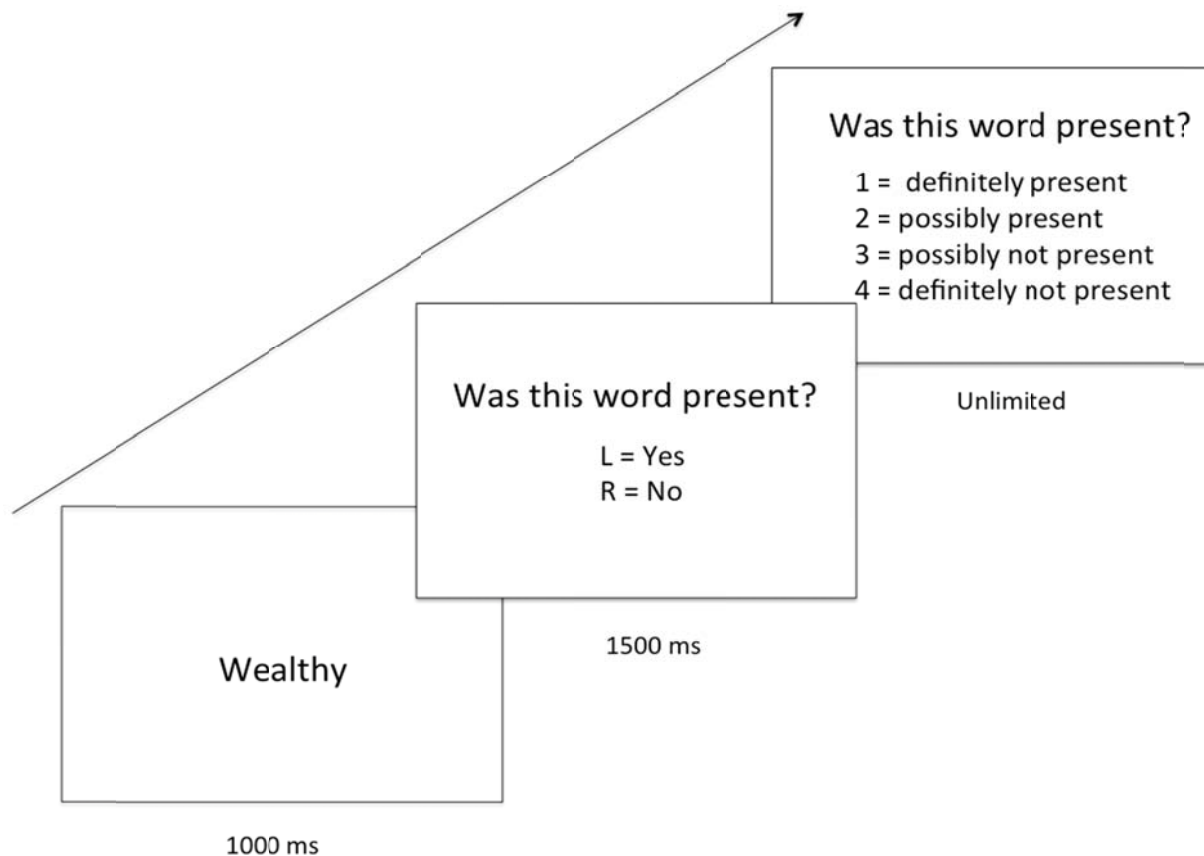


Figure 2. Schematic of recognition phase of affective memory task

## 2.4 Statistical Analyses

**2.4.1 Analysis 1: Potentially confounding variables.** We first sought to control for the effect of demographic and clinically related variables in our main analyses. Potential variables included age, sex, and clinical variables like previous diagnoses of, or treatment for psychological disorders. Because anhedonia is a core symptom of depression, we examined the relationship between semantic memory abnormalities and depressive symptoms. We used hierarchical linear regression to control for depressive symptoms by entering BSI scores as a predictor variable and the difference in reaction times between targets and non-targets as the criterion variable in a hierarchical linear regression equation. This analysis was designed to test the hypothesis that depressive symptoms, and other potentially confounding factors like demographic and treatment related variables, would be unrelated to abnormalities in semantic memory use.

**2.4.2 Analysis 2: State anhedonia.** In order to address the first aim of examining state anhedonia in schizotypy, we measured state anhedonia by examining the current affect rating to the positively valenced affective word groups. Because anhedonia is often conceptualized as reductions in positive affect, rather than increased negative affect, we were particularly interested in responses to positive stimuli in the following analyses. We used hierarchical linear regression to examine the hypothesis that state anhedonia would be significantly related to schizotypy. To do this, we entered Schizotypal Personality Questionnaire-BR (SPQ-BR) scores as the predictor variable and Likert scores of affective ratings of the word groups as the criterion variable.

**2.4.3 Analysis 3: Manipulation check.** To determine whether our manipulation was effective, we examined the difference in reaction times, response accuracy, and confidence of responses to semantically congruent targets, semantically incongruent targets, and semantically congruent lures in order to ensure that subjects exhibited the expected trend of responses. We examined the average reaction time of each set of targets for our sample with the expectation that responses to semantically congruent targets would be recognized with the lowest latency, semantically incongruent targets would be recognized with the next higher latency, and semantically congruent lures would be recognized with the greatest latency. Because our reaction time data were positively skewed, we used a square root transformation to reduce the skew and make the data closer to normality.

**2.4.4 Analysis 4: Schizotypy, anhedonia, and the affective memory task.** We used a set of hierarchical linear regression equations advocated by Baron and Kenny (1986) to examine the relationship between schizotypy, anhedonia, and semantic memory abnormalities. The first hierarchical linear regression, taken from Analysis 2, examined the relationship between schizotypy and state anhedonia. This analysis tested the hypothesis that schizotypy would be

significantly related to state anhedonia by entering self-reported schizotypy scores as the predictor variable and Likert scores of current affective ratings as the criterion variable. The second hierarchical linear regression examined the relationship between schizotypy and semantic memory abnormalities, and tested the hypothesis that abnormalities in semantic memory use would mediate the relationship between schizotypy and state anhedonia as measured by a commonly used measure of semantic bias (the difference between reaction times to targets and lures; Coane et al., 2007; Hancock, Hicks, Marsh, & Ritschel, 2003; Jou, Matus, Aldridge, Rogers, & Zimmerman, 2004). This was achieved by entering state anhedonia as the predictor variable and semantic memory abnormalities as the criterion variable. The third hierarchical linear equation examined the mediating role of abnormalities in semantic memory on the relationship between schizotypy and current affective ratings by entering both schizotypy and semantic memory performance as predictor variables and current affective ratings as the criterion variable.

A second set of analyses examined reaction times to targets and lures, but included only responses in which subjects responded affirmatively that they had been exposed to the stimulus in the encoding phase (i.e., correct answers to targets and false alarms to lures, excluding correct rejections of targets and correct rejections of lures), and are therefore referred to as “affirmative responses”. These, analyses of affirmative responses did not differ from the analyses of all responses, with the exception of the set of analyses in which disorganized schizotypy was used as an independent variable predicting state anhedonia. No other mediation model differed between these two alternative analyses. However, because the analyses examining affirmative responses sought to examine a relatively rare event (false alarms to lures) and accuracy was generally high, it examined fewer cases than the analyses examining all responses. Further

complicating the analyses of affirmative responses was the notable variability of these responses (mean reaction times and standard deviations are displayed alongside means and standard deviations of reaction times of all responses to targets and lures in table 3 for reference). Therefore, with the exception of the indirect effect analyses examining the disorganized subscale, where data are provided for analyses examining all responses, as well as analyses examining affirmative responses, the data below are presented with all responses in order to ensure adequate power.

**2.4.5 Analysis 5: Semantic bias and quality of life.** As neurocognitive functioning has been shown to be highly related with functional outcome (Milev, Ho, Arndt, & Andreasen 2005), we examined the relationship between semantic memory abnormalities and functional outcome. To do this, semantic memory performance was entered into a hierarchical linear regression as a predictor variable and Quality of Life (QoL) scores (as measured by scores on a self-report Quality of Life measure) was entered as the criterion variable.

**2.4.6 Exploratory analyses.** A set of exploratory analyses examining the relationship between negative, positive, and disorganized schizotypy and semantic and episodic memory abnormalities was performed. In these analyses, we performed Pearson's  $r$  correlations between each facet of schizotypy (positive, negative, and disorganized, respectively) and the difference in reaction times between targets and non-targets to examine the relationship between performance and schizotypy subtype. Additionally, these three facets were used in a set of regression analyses identical to the main analyses. Finally, following some indications that difference scores make interpretation of results somewhat complicated, an alternative measure of semantic bias was used as a potential mediator in a set of analyses identical to the main analysis above.

## 2.5 Power Analysis

Based on prior research findings, individuals with schizotypy report greater anhedonia than controls on the order of 0.7 - 0.8 standard deviations lower than controls (Cohen et al., 2012). However, the current study, at its core, was proposed to engage episodic memory functioning for emotional stimuli, findings from the relevant literature (Cohen's *d* values ranging between 0.31 and 0.68) were considered in estimating an expected effect size (Hoshi, Scoales, Mason, & Kamboj, 2011). A priori power analysis suggested that a total of 80 participants utilizing three predictors were necessary to achieve a medium effect size with a power of at least 0.80 and alpha of level of 0.05 (Cohen, 1992; Calculated with G\*Power; Faul, Erdfelder, Lang, & Buchner, 2007).

## CHAPTER 3. RESULTS

### 3.1 Demographics and other potentially confounding variables

Table 1 contains descriptive statistics for our sample. Sex, race, and ethnicity were all unrelated to accuracy of responses, confidence ratings, or our reaction time-based measures of semantic bias (see table 2). Age, however, was related to both measures of semantic bias (measure utilizing difference scores ( $r(92) = .24$ ;  $p = .02$ ) and the measure utilizing the regression approach ( $r(92) = .28$ ;  $p = .01$ )). Because age was related to semantic bias, it was controlled for in all following analyses in which semantic bias was the independent variable. Paradoxically, history of psychiatric treatment was significantly negatively correlated with self-reported schizotypy scores ( $r(90) = -.24$ ;  $p = .02$ ). History of psychological treatment was controlled for in all analyses examining schizotypy as a predictor. Self-reported depression scores were significantly correlated with self-reported schizotypy ( $r(89) = .66$ ;  $p < .001$ ) but were not significantly correlated with semantic bias ( $r(89) = -.04$ ;  $p = .69$ ). Self-reported depression symptoms were therefore controlled for in all analyses examining schizotypy as a predictor. However, because semantic bias and depression were not related, self-reported depressive symptoms were not controlled for in analyses examining semantic bias as a predictor. No other clinical or demographic variable was significantly related to performance on the affective memory task, self-reported schizotypy, or current affective ratings.

Table 1. Descriptive statistics for laboratory sample

Age	20.11 (1.49)
% Female	82.6%
% Caucasian	69.2%
SPQ-BR Total Score	47.62 (18.25)
SPQ-BR Positive Score	21.47 (10.94)
SPQ-BR Negative Score	16.72 (8.22)
SPQ-BR Disorganized Score	17.65 (6.71)



BSI Total Scores 102.02 (36.97)  
 BSI Depression Scores 12.83 (4.95)

History of psychological treatment was controlled for in all analyses examining schizotypy as a predictor. Self-reported depression scores were significantly correlated with self-reported schizotypy ( $r(89) = .66$ ;  $p < .001$ ) but were not significantly correlated with semantic bias ( $r(89) = -.04$ ;  $p = .69$ ). Self-reported depression symptoms were therefore controlled for in all analyses examining schizotypy as a predictor. However, because semantic bias and depression were not related, self-reported depressive symptoms were not controlled for in analyses examining semantic bias as a predictor. No other clinical or demographic variable was significantly related to performance on the affective memory task, self-reported schizotypy, or current affective ratings.

Table 2. Correlations between potentially confounding variables and independent variables

	Sex	Age	Race	Ethnicity	Psychological treatment	Depressive symptoms
Self-reported schizotypy	.02	-.12	.10	-.11	-.24*	.66**
Affective valence ratings	-.12	.25*	.02	.08	.12	.22*
Reaction time	-.09	.22*	-.20	-.07	-.16	-.04
Semantic bias (residualized)	-.05	.28*	-.01	.05	.07	-.06
Semantic bias (difference)	.02	.28*	.03	-.01	.17	-.04
Confidence ratings	.01	.01	-.05	.05	.01	.24*
Response accuracy	-.31	.14	-.05	-.22	-.01	-.22

\*  $p < .05$

\*\* $p < .001$

## 3.2 Anhedonia

Participants evidenced a mean physical anhedonia score of 4.78 (2.09) and a mean social anhedonia score of 7.83 (2.21) on the Chapman Anhedonia Scales. Participants reported a mean current affective rating of 6.13 (1.67) in response to the positive stimuli. They reported a mean current affective rating of 4.37 (1.92) in response to the negative stimuli and a mean current affective rating of 5.36 (1.78) in response to the neutral stimuli. An omnibus ANOVA indicated that there was a significant difference between responses in each valence condition. Follow-up analyses, adjusted using a Bonferoni correction, confirmed that each set of valence ratings was significantly different from the other valence ratings ( $p$ 's < .001). This measure indicates that our manipulation of affect was effective at a subjective level.

## 3.3 Manipulation check

**3.3.1 Reaction Times.** Across affectively valenced stimuli, reaction times to targets were significantly faster than reaction times to lures ( $F(1, 89) = 28.68; p < .001$ ; see table 3). Reaction times were not significantly different between valence conditions ( $F(2, 88) = 2.40; p = .09$ ). Consistent with research examining reaction times in false memory research, semantically congruent lures were expected to yield higher latencies (Coane et al., 2007; Hancock et al., 2003; Jou et al., 2004). Participants performed as expected; collapsing across positive, negative, and neutral valence conditions (neutral stimuli did not include semantically congruent or incongruent stimuli, so all neutral targets were collapsed and included in the current analysis), latencies were higher in response to semantically congruent lures than to all other targets ( $t(90) = 4.81; p < .001$ ; see figure 3). This pattern of faster responses to targets than to lures than to true targets is consistently reported in the literature examining reaction time in false memory paradigms, and thus allowed us to make the conclusion that our manipulation of memory was effective.

Because our main analyses examined a composite score of reaction times to targets and lures, we first examined whether self-reported schizotypy was significantly related to reaction times to either targets or lures. Self-reported schizotypy scores were not significantly correlated with reaction time for targets ( $r(92) = -.13; p = .23$ ) or lures ( $r(90) = -.2; p = .06$ ).

Table 3. Reaction time across valence conditions

<u>Positive Stimuli</u>	<u>Reaction Time</u>
Congruent targets	768.66 (379.08)
Incongruent targets	781.30 (463.76)
Congruent false targets	888.46 (469.81)
Incongruent false targets	869.05 (490.19)
<u>Negative Stimuli</u>	<u>Reaction Time</u>
Congruent targets	711.95 (401.45)
Incongruent targets	669.46 (427.51)
Congruent false targets	851.32 (446.54)
Incongruent false targets	861.02 (479.93)
<u>Neutral Stimuli</u>	<u>Reaction Time</u>
Targets	735.71 (358.62)
False targets	823.33 (380.62)

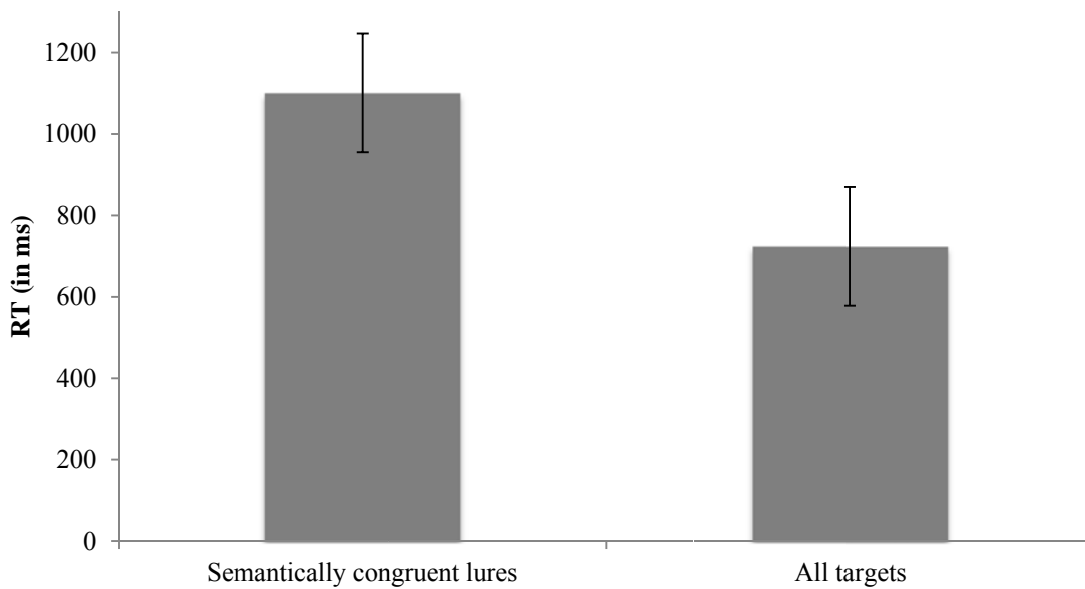


Figure 3. Reaction time to semantically congruent false targets and all other targets

**3.3.2 Response Accuracy.** The overall mean accuracy for all targets collapsing across valence was .77 (.13). Accuracy did not differ by valence ( $F(2, 40) = 2.41; p = .10$ ; table 4). Overall, there was a significant difference between accuracy of responses to targets (.85 (.11)) and lures (.74 (.14);  $t(59) = 5.48; p = .001$ ). Because the responses were not forced choice, we received an average non-response rate of 2.15 trials (2.58) out of a possible 36 trials.

There is a strong inverse relationship between reaction time and accuracy in behavioral studies, broadly defined (Wickelgren, 1977). Because reaction time was the primary measure of semantic bias in the current study, it was important to examine the relationship between schizotypy and accuracy of responses in order rule out any confounds in the main analyses. Schizotypy was negatively correlated at a trend level with accuracy of responses to negative targets ( $r(65) = -.24; p = .052$ ). Schizotypy was unrelated to all other measures of accuracy for positive and negative targets ( $r$ 's =  $-.13 - .04; p$ 's =  $.76 - .28$ ) or lures ( $r = -.17 - .15; p$ 's =  $.71 - .21$ ).

Table 4. Accuracy across valence conditions

<u>Positive Stimuli</u>	<u>Accuracy</u>
Congruent targets	.88 (.21)
Incongruent targets	.88 (.21)
Congruent false targets	.72 (.29)
Incongruent false targets	.62 (.31)
<u>Negative Stimuli</u>	<u>Accuracy</u>
Congruent targets	.90 (.20)
Incongruent targets	.84 (.24)
Congruent false targets	.51 (.36)
Incongruent false targets	.76 (.22)
<u>Neutral Stimuli</u>	<u>Accuracy</u>
Targets	.81 (.21)
False targets	.73 (.26)

**3.3.3 Confidence ratings.** Overall, subjects were more confident in their responses to targets than to lures in all valence conditions (table 5). Across valence conditions, confidence for targets was rated significantly higher and deviated further from absolute certainty of the targets' presence than absolute certainty of the lures' absence ( $t(91) = 6.53; p < .001$ ). Average confidence for targets was rated 3.33 (.57); deviating from 4, or "word was present", whereas confidence for lures was rated 2.18 (.53; deviating from 1, or "word was absent"). Confidence was significantly different across affective conditions ( $F(1, 91) = 43.81; p < .001$ ). Subjects were less confident in their responses to both targets and lures in the neutral condition than in the positive or negative condition (see table 5). There was a nonsignificant trend difference between confidence in the positive (rated 2.84 (.49) and negatively (rated 2.91 (.49)) valenced conditions ( $F(1, 91) = 3.73; p = .06$ ).

While reaction time was the primary measure in the current study, ratings of confidence in response to targets and lures may reflect a secondary measure of bias. We therefore sought to examine the relationship between schizotypy and confidence ratings. Self-reported schizotypy was significantly correlated with higher confidence ratings on positive targets ( $r(91) = .22; p = .04$ ). Schizotypy was not significantly related to any other measure of confidence ( $r$ 's = .02 - .17;  $p$ 's > .11).

### **3.4 Schizotypy, anhedonia, and the affective memory task: Mediating effects of semantic bias**

Because anhedonia is often conceptualized as reductions in positive affect, rather than increased negative affect, positive stimuli were used in the following analyses. The accuracy, confidence, and reaction time measures for positive stimuli alone were reflective of the results across valence, indicating that our sample did not respond to the positive condition in a

categorically distinct way. This suggests that it was appropriate to examine only positive stimuli for the remaining analyses.

The following analyses were performed separately with and without controlling for demographic and clinical variables (e.g., age, history of psychological treatment, and depressive symptoms). The inclusion of these variables was associated with single unsystematic differences between individual paths in each mediation model analyzed. However, there were no significant differences between overall indirect effects, with the exception of changing the indirect effect examining the mediating effect of semantic bias on the relationship between disorganized schizotypy and state anhedonia from significant to nonsignificant. All other analyses did not change. Because these demographic and clinical variables correlated significantly with our independent variables of interest and at least some of these variables are differentially related to relationship between disorganized schizotypy and anhedonia as compared to the relationship between negative and positive schizotypy and anhedonia, the data presented below include demographic and clinical variables as covariates.

**3.4.1 Schizotypy and state anhedonia.** Self-reported schizotypy was significantly correlated with self-reported state anhedonia  $r(85) = -.34, p < .001$ . The first simple linear regression in the Baron-Kenny model indicated that schizotypy was a significant predictor of state anhedonia ( $b = -.40, t(91) = -3.03, p = .003, R^2 = .14$ ).

**3.4.2 Schizotypy and semantic bias.** The second linear regression in the Baron-Kenny model examined schizotypy and the difference between reaction times to targets and lures. Schizotypy was not correlated significantly with semantic bias ( $r(91) = -.14; p = .20$ ). Schizotypy was not a significant predictor of semantic bias ( $b = -.19; t(91) = -1.32; p = .19, R^2 = .02$ ).

**3.4.3 Semantic bias, schizotypy, and state anhedonia.** A test of indirect effects indicated that the relationship between schizotypy and state anhedonia was not significantly mediated by our measure of semantic bias, suggesting there was no indirect effect of semantic bias on the relationship between self-reported schizotypy and state anhedonia. Indirect effect = .005;  $p = .26$ . See table 6 for summary statistics of the indirect effects.

Table 6. Summary of indirect effects for mediation model

Predictor	Outcome	b	SE <sub>b</sub>	β
Schizotypy	State anhedonia	-0.04	0.01	-0.39
Schizotypy	Semantic bias	-4.65	3.80	-0.17
Semantic bias	State anhedonia	-0.001	0.0003	-0.22
Schizotypy + semantic bias	State anhedonia	-0.04	0.01	-0.40

### 3.5 Exploratory analyses

**3.5.1 Heterogeneity in schizotypy and the affective memory task.** There is significant heterogeneity in schizotypy. Positive, negative, and disorganized symptoms are differentially associated with abnormalities along both cognitive (Kerns, 2006) and affective (Martin et al., 2011) domains, suggesting this mediating relationship of semantic bias may vary as a function of schizotypy facet. We therefore examined each facet of schizotypy separately, subjecting each to our main analysis as predictors of anhedonia. Disorganized schizotypy was the only facet that correlated significantly with our measure of semantic bias ( $r(91) = -.21$ ;  $p = .04$ ). Neither positive ( $r(91) = -.08$ ;  $p = .48$ ) nor negative ( $r(91) = -.08$ ;  $p = .46$ ) schizotypy were significantly correlated with semantic memory bias. This analysis informs our analyses and suggests that disorganized, but not positive or negative schizotypy is related to our measure of semantic bias and is therefore worthy of further inquiry.

**3.5.1.1 Schizotypy facets and state anhedonia.** We first examined the relationship between each individual facet of schizotypy and current affective rating. As with overall schizotypy scores, the first simple linear regression in the Baron-Kenny model examined

positive, negative, and disorganized schizotypy, respectively and anhedonia. Disorganized schizotypy did not predict state anhedonia ( $b = .19, t(91) = -1.83, p = .70, R^2 = .04$ ). Conversely, both positive ( $b = -.29, t(91) = -2.85; p < .001, R^2 = .08$ ) and negative ( $b = -.37, t(91) = -3.80, p < .001; R^2 = .14$ ) schizotypy were significant predictors of state anhedonia. Our results indicate that, as expected, anhedonia is significantly more highly related to some facets of schizotypy, than others.

**3.5.1.2 Facets of schizotypy and semantic bias.** Some prior studies have shown that cognitive deficits cluster differentially across positive, negative, and disorganized symptom dimensions (O’Leary et al., 2000). We therefore examined the relationship between semantic bias and positive, negative, and disorganized schizotypy. The second linear regression in the Baron-Kenny mediational model examined disorganized symptoms and semantic bias. Disorganized schizotypy was a significant predictor of semantic bias ( $b = -.21, t(91) = -2.06; p = .04, R^2 = .05$ ). However, neither positive ( $b = -.08, t(91) = -.71; p = .48, R^2 = .01$ ), nor negative, ( $b = -.10, t(91) = -.98; p = .33, R^2 = .01$ ) symptoms of schizotypy were a significant predictor of semantic bias. Our results indicate that semantic bias is significantly more highly related to disorganized schizotypy, than to positive or negative schizotypy.

**3.5.1.3 Semantic bias, schizotypy facets, and state anhedonia.** The results of our mediation model indicated that negative schizotypy was highly related to current affective ratings, and that disorganized schizotypy is highly related to semantic bias. However, no single facet was significantly related to both current affective ratings and semantic bias. We therefore used a test of indirect effects to examine the mediating effect of semantic bias on the relationship between each respective facet of schizotypy and in-the moment affective ratings. A series of tests of indirect effects indicated that the relationship between disorganized schizotypy and our



measure of state anhedonia was significantly mediated by our measure of semantic bias (Indirect effect = .024;  $p = .05$ ). Neither positive (Indirect effect = .003;  $p = .60$ ), nor negative schizotypy (Indirect effect = .002;  $p = .73$ ) was significantly mediated by our measure of semantic bias. All indirect effects for positive, negative, and disorganized schizotypy are presented in table 7.

Table 7. Indirect effects for positive, negative, and disorganized facets of schizotypy

Predictor	Outcome	b	SE <sub>b</sub>	$\beta$
<u>Positive Schizotypy</u>				
Schizotypy	State anhedonia	-0.04	0.02	-0.24
Schizotypy	Semantic bias	-3.19	5.98	-0.07
Semantic bias	State anhedonia	-0.001	0.0004	-0.18
Schizotypy + semantic bias	State anhedonia	-0.034	0.02	-0.23
<u>Negative Schizotypy</u>				
Schizotypy	State anhedonia	-0.07	0.02	-0.33
Schizotypy	Semantic bias	-2.48	7.18	-0.04
Semantic bias	State anhedonia	-0.001	0.0003	-0.19
Schizotypy + semantic bias	State anhedonia	-0.07	0.02	-0.34
<u>Disorganized Schizotypy</u>				
Schizotypy	State anhedonia	-0.04	0.03	-0.17
Schizotypy	Semantic bias	-24.02	9.25	-0.33
Semantic bias	State anhedonia	-0.001	0.0004	-0.21
Schizotypy + semantic bias	State anhedonia	-0.05	0.03	-0.19

The alternative analyses of affirmative responses did not change our findings for positive (Indirect effect = .001;  $p = .86$ ) or negative schizotypy (Indirect effect = .004;  $p = .60$ ).

However, in examining data including only affirmative responses, semantic bias did not significantly mediate the relationship between disorganized schizotypy and state anhedonia, as was the case in the analyses examining all responses (Indirect effect = .001;  $p = .97$ ). We examined effect sizes of each path of the respective models in order to further explore the difference between the two indirect effect models. The overall effect size for the analyses examining all responses to targets and lures, obtained by multiplying the partial correlations for the relationships between disorganized schizotypy and state anhedonia, and semantic bias and state anhedonia, was in the small range ( $r_{\text{schizotypy.anhedonia}} \cdot r_{\text{bias.schizotypy}} = .04$ ). The effect size for

this relationship examining affirmative responses was in the negligible range ( $r_{\text{schizotypy.anhedonia} \cdot r_{\text{bias.schizotypy}}} = .002$ ). Examining the individual paths in each model helped to confirm the difference between these models. The partial correlations between disorganized schizotypy and semantic bias in the model examining all responses was  $r_{\text{schizotypy.anhedonia}} = -.22$ . For the analyses examining only correct responses and false alarms, the partial correlation between disorganized schizotypy and semantic bias was  $r_{\text{schizotypy.anhedonia}} = -.38$ . The partial correlation between semantic bias and state anhedonia was  $r_{\text{bias.schizotypy}} = -.21$  for all responses, whereas the partial correlation between semantic bias and state anhedonia in the correct hits and false alarms only was  $r_{\text{bias.schizotypy}} = -.01$ .

**3.5.2 Reconceptualizing semantic bias.** It has been demonstrated that difference scores sometimes exhibit some problematic psychometric properties, and may benefit if substituted for a regression model (Edwards, 1994). Therefore, as an exploratory analysis, we completed the above analyses with a theoretically more psychometrically sound conceptualization of semantic bias by regressing reaction times to semantically congruent lures onto the reaction times to all targets (thus creating a standardized measure of the divergence from the average amount of incongruence between scores).

**3.5.2.1 Schizotypy and state anhedonia.** As above, the first simple linear regression in the Baron-Kenny model examined disorganized schizotypy and anhedonia. This relationship did not involve the alternative measure of semantic bias, and thus is equivalent to the initial analysis. As reported above, schizotypy was significantly correlated with state anhedonia ( $r(91) = -.36, p < .001$ ). Schizotypy was a significant predictor of state anhedonia ( $b = -.39, t(91) = -2.92, p = .005, R^2 = .15$ ).

**3.5.2.2 Schizotypy and semantic bias.** Our alternative conceptualization of semantic bias is a measure that does not rely upon difference scores. This alternative conceptualization examined the standardized residual of a regression equation in which reaction times in response to targets were regressed upon the reaction times in response to lures. This conceptualization was theorized to more accurately capture the variation between lures and targets and provide a more stable measure of semantic bias and avoids regression to the mean, as it provided a standardized measure of deviation from the predicted reaction time for a given subject (Willett, 1988). Therefore, the second linear regression in the Baron-Kenny model examined self-reported schizotypy and our alternative measure of semantic bias. Schizotypy was not correlated significantly with this alternative measure of semantic bias ( $r(91) = -.19; p = .08$ ). Schizotypy was not a significant predictor of this new measure of semantic bias ( $b = -.24; t(91) = -1.72; p = .09; R^2 = .04$ ). The nonsignificant relationship with a theoretically more psychometrically sound alternative measure of semantic bias suggests that using reaction times, overall schizotypy was indeed not significantly related to semantic bias.

**3.5.2.3 Semantic bias, schizotypy, and state anhedonia.** Self-reported schizotypy was a significant predictor of current affective ratings, but was not associated with our alternative conceptualization of semantic bias. A second series of tests examined the mediating effect of this measure of semantic bias on the relationship between self-reported schizotypy and current affective ratings. As in the above analyses, the relationship between schizotypy and state anhedonia was not mediated by the alternative measure of semantic bias. The indirect effect of semantic bias was not significant (Indirect effect = .003;  $p = .31$ ). As before, our results indicate that our alternative measure of semantic bias could not account for the relationship between schizotypy and current affective ratings.

### 3.6 Semantic bias and quality of life

Overall, semantic bias was not a significant predictor of quality of life. However, there was a significant relationship between semantic bias and select domains of quality of life, including amount of time spent doing household activities was a significant predictor of semantic bias ( $b = .20, t(84) = 2.43, p = .02$ ). Additionally, there was a trend relationship between semantic bias and amount of time spent participating relaxing ( $b = .38, t(84) = 1.73, p = .09$ ). No other facet of quality of life was significantly related to schizotypy. See table 8 for summary statistics for this regression.

Table 8. Summary regression statistics examining semantic bias and Quality of Life

QOL Predictor	b	SE <sub>b</sub>	β
Paid employment	0.01	0.04	0.04
School, class, therapy	0.01	0.05	0.05
Transportation	0.01	0.08	0.02*
Household activities	0.20	0.08	0.36
Caretaking	0.05	0.06	0.12
Eating	0.05	0.08	0.09
Sleeping	0.09	0.06	0.29
Exercising	0.01	0.08	0.02
Relaxing	0.12	0.07	0.38 <sup>†</sup>
Recreational activities	0.002	0.06	0.01

\*  $p < .05$

<sup>†</sup>  $p < .09$

## CHAPTER 4. DISCUSSION

The accessibility model of emotional self-report has been proposed as a solution to the dissociation between current and noncurrent reports of anhedonia across the schizophrenia spectrum. The current study sought to expand prior research to understand this dissociation by applying the accessibility model to a group of individuals who are high in schizotypy in an attempt to understand the mediating effect of semantic memory bias on the relationship between schizotypy and state anhedonia. To this end, the current study adapted a commonly used false memory paradigm to include affectively valenced stimuli in a group of individuals with psychometrically defined schizotypy. Our results indicate that in individuals high in disorganized symptoms, biases in semantic memory were one significant partial mediating factor in their current affective ratings. Several other interesting relationships occurred between current affective ratings, memory performance, and psychometrically defined schizotypy. Our results partially support the mediating role of semantic memory bias in the relationship between schizotypy and current affective ratings, however this was true only in disorganized schizotypy and these findings did not replicate in overall schizotypy scores, nor in any other facet of schizotypy. The current findings are an interesting extension of the accessibility model of emotional self-report in schizophrenia, but only partially support the model of in state anhedonia in schizotypy.

### 4.1 Schizotypy and state anhedonia

Consistent with prior literature (e.g., Blanchard, Collins, Aghevli, Leung, & Cohen, 2011; Brown & Silvia, 2008), schizotypy was significantly correlated with self-reported state anhedonia. Self-reported schizotypy scores were significant predictors of current affective ratings in response to positively valenced stimuli. This relationship was limited to self-reported

schizotypy; self-reported depression scores were not significantly related to current affective ratings of positive stimuli, suggesting that these measures assessed distinct constructs and that schizotypy was not subsumed within the construct of self-reported depressive symptoms. This pattern of results is consistent with findings in the affective science literature in that anhedonia is differentially associated with clinical manifestations of each respective disorder (Pelizza & Ferrari, 2009). This is important because it allowed us to make the assertion that schizotypy, and not depression is uniquely predictive of current affective ratings.

There were differential relationships between distinct domains of schizotypy and current affective ratings. Both positive and negative schizotypy were significant predictors of affective ratings, whereas disorganized schizotypy was not. This pattern of relationships is consistent with the discreet nature of positive, negative, and disorganized subtypes of schizotypy (Raine et al., 1994). The relationship between negative schizotypy and current affective ratings is, therefore, not surprising given that the core features of negative schizotypy are associated with apathy and include symptoms linked to anhedonia (Cohen & Matthews, 2010); and are associated with increased negative and decreased positive affect (Horan, Blanchard, Clark, & Green, 2008). Disorganized schizotypy is not typically related to current reports of anhedonia (Loas, Verrier, & Monestes, 2014; Raine et al., 1994). Our results were consistent with this finding, in that self-reported disorganized symptoms of schizotypy were not significantly correlated with current affective ratings. However, the significant relationship between positive schizotypy and in-the-moment affective ratings is not wholly consistent with the literature, in that prior studies have found mixed evidence for the relationship between positive schizotypy and anhedonia (Blanchard, Horan, & Brown, 2001, but see Kwapil, Barrantes-Vidal, & Silvia, 2008). Thus, it is interesting (and not entirely clear why) positive schizotypy was related to current affective

ratings, given the structure of positive schizotypy and its relationship with perceptual aberrations, ideas of reference, and magical ideation (Raine et al., 1994).

#### **4.2 Schizotypy and semantic memory bias**

Overall, our data indicate that the accessibility model of self-report is a potential model of anhedonia in disorganized (but not positive, negative, or overall) schizotypy. Expanding upon previous work examining current and non-current affective reports in schizotypy, the accessibility model would hold that when queried about temporally recent emotions, individuals with schizotypy substitute episodic emotional information with more generalized and negatively biased semantic knowledge. The current study sought to investigate the relationship between semantic memory bias and current affective responses in order to examine the importance of semantic memory systems in response to novel memories of emotional stimuli in a laboratory setting. The results of the current study indicate that overall self-reported schizotypy scores were not significantly related to either of our two measures of semantic bias. While paradigms like the one used in the current study have been shown to be associated with a spreading activation (Roediger, Balota, & Watson, 2001), only disorganized schizotypy was a significant predictor of this semantic bias, suggesting that the accessibility model of self-report does not account for reports of state anhedonia broadly across psychometrically defined schizotypy but might be a useful heuristic in explaining disorganized schizotypy.

Several explanations exist for the nonsignificant relationship between overall schizotypy scores and semantic bias. One possible explanation for the nonsignificant relationship between total schizotypy scores and semantic biases is that our measure of semantic bias was not a sufficient indicator of semantic bias. We used a difference score of reaction times to targets and lures as our indicator of semantic bias. However, prior research suggests that the validity of

difference scores may be problematic (Edwards, 1994). While prior studies examining semantic bias use reaction time as a primary measure, fewer studies use a difference score as a primary measure. Our alternative measure of semantic bias did not include a difference score, and similar results were obtained. This indicates that the nonsignificant finding was not attributable solely to the use of difference scores, and suggests that the nonsignificant mediating relationship of semantic memory bias, as measured by the difference between targets and lures, was a true null result and not the product of variable choice.

Previous literature implicates abnormal semantic activation – characterized by greater frequency of distally related concepts becoming activated in semantic memory systems, as a potential mechanism behind disorganized symptoms (Pomarol-Clotet, Oh, Laws, & McKenna, 2008). Abnormalities in semantic activation have been proposed as important in understanding key symptoms in the disorganized subtype, including disorganized speech, in that wider associations in semantic networks in individuals with increased disorganized symptoms (Minor, Cohen, Weber, & Brown, 2011). The mechanism behind this abnormal semantic activation is associated with disorganization in the semantic memory system. Coupled with reduced ability to inhibitory processes, this mechanism leads to reduced semantic priming effects and more unrelated associations in semantic fluency (Niznikiewicz, Mittal, Nestor, & McCarley, 2010; Tan, Neill, & Rossell, 2015). The accessibility model of emotional self-report posits that this abnormal semantic activation is contributes to the pattern of current and non-current affective states in schizophrenia. Our pattern of findings in which disorganized schizotypy was the only facet of schizotypy related with semantic biases can be interpreted in the context of this mechanism, suggesting that this model accounts for the cognitive performance in disorganized schizotypy.



### 4.3 Semantic bias, schizotypy, and state anhedonia

Contrary to our hypothesis, semantic bias was not a significant mediator of the relationship between schizotypy and state anhedonia. These results did not differ when examining each either positive or negative facets of schizotypy as separate predictors or when using our revised measure of semantic bias as the mediator variable. However, there was a significant mediating relationship when the disorganized schizotypy facet was used as a predictor of current affective ratings. Examining the three separate steps of the Baron-Kenny model helped to clarify the relationships in this model. The relationship between schizotypy and self-reported current affective ratings was significant. However, both measures of semantic bias were significantly related only to disorganized schizotypy, and were not significantly related to overall self-reported schizotypy scores. Furthermore, neither measure of semantic bias was significantly related with current affective ratings.

The significant mediating effect of semantic bias on the relationship between disorganized schizotypy and current affective ratings indicates that in those individuals with disorganized symptoms, semantic biases are a significant factor in level of positive affect that individuals report experiencing after having seen a list of positive words. This was an interesting finding because disorganized schizotypy was not a significant predictor of current affective ratings. Importantly, each step in this mediation model is not necessarily required to be statistically significant to obtain a partial mediation (Baron & Kenny, 1986). This result indicates that disorganized schizotypy is differentially associated with semantic bias as a mediator of current affective ratings. This relationship did not hold when we examined only correct responses to targets and false alarms in response to lures. As detailed above, chief among the possibilities for this change is that this measure examined false alarms, which occurred

relatively infrequently as illustrated by the descriptive statistics examining accuracy data. A second concern was the variability in the data. Fewer trials introduce greater variability. Our reaction time data were highly variable, which may explain the reduction in significance in our significant indirect effect between disorganized schizotypy and state anhedonia.

One potential explanation for the nonsignificant mediation in overall schizotypy is that the mediating effect of semantic memory bias varied in strength across schizotypy facets. Perhaps this mechanism of semantic bias is only applicable in individuals high in disorganized symptoms, whereas other mechanisms account for the abnormalities in other facets of schizotypy. This is partially consistent with prior literature, indicating that semantic bias and cognitive functioning vary across facets of schizotypy with greater associations between disorganized schizotypy and reduced confidence in their thoughts and beliefs, whereas positive schizotypy is associated with increased confidence in their thoughts (Sacks et al., 2012).

Several explanations detailed above might explain the largely nonsignificant mediating relationship of semantic biases on the relationship between schizotypy and current affective ratings. One such explanation is that the effect of semantic bias is subtle and exists as only one factor in current affective ratings. Although prior research found medium to large effect sizes of semantic memory deficits, the task used in the current study was not designed to be psychometrically matched to the task used in these studies. Perhaps because the current paradigm was measuring a specific facet within the semantic memory system, we did not see broader deficits like those found in more general studies of semantic memory in schizotypy (Hoshi et al., 2011). Our mediational analysis failed to indicate a significant mediating effect of semantic memory bias, with the exception of in disorganized schizotypy. However, select results helps to further parse our findings. Our manipulations of affect and of semantic

coherence appear to have been effective, at least on a subjective level. Overall, participants reported feeling more positive after being exposed to positive stimuli than after being exposed to negative or neutral stimuli and reported feeling more negative after being exposed to negative stimuli than when exposed to positive or neutral stimuli. Further, participants were slower to respond to semantically related lures than semantically unrelated lures, suggesting that reaction time was a valid measure of semantic bias.

#### **4.4 Limitations**

The current study is the first to examine the relationship between semantic memory bias and anhedonia in psychometrically defined schizotypy. However, our findings were not without some limitations. First, the construct of “semantic bias” is a relatively novel construct, as relates to state affective responses. Prior research has posited that this semantic bias is the mechanism by which individuals with schizophrenia exhibit deficits in self-reported anhedonia (Strauss & Gold, 2012). Little work has been done to clarify the nature of this deficit and how it affects individuals across the schizophrenia spectrum. This theoretical work points to deficits in a range of memory systems that may lead to overreliance on the semantic memory systems in individuals diagnosed with schizophrenia. However, the current study is the first to empirically test this hypothesis in individuals with schizotypy. Future work may further examine this construct across the schizophrenia spectrum through combined experimental design and continued theory-driven conceptual work.

A second potential limitation is in the current study is the use of reaction time data during a false memory task. While reaction times have been used in a number of experimental paradigms to approximate mental processes, and increasingly in false memory paradigms (for examples, see Coane et al., 2007; Lopes & Garcia, 2014), this is still a relatively new paradigm,

and interpretation of these data reaction time data present some conceptual concerns in that these data are often difficult to interpret. While this concern is understandable, several studies mentioned above have examined the validity of reaction times in false memory paradigms like the one used in the current study, and this type of data appears to exhibit convergent validity with more traditional studies of false memory. Furthermore, we were careful to check assumptions of normality and to transform reaction time data when necessary in the current study, which should reduce any concerns with the use of reaction time data in the false memory paradigm.

As alluded to above, might include difficulties obtaining sufficient power to sufficiently detect a true effect. We obtained less than perfect response rates to this speeded task, which may have caused a reduction in power. Overall, though, we received relatively high response rates (95% of subjects responded “Yes” or “No” to 78% of the targets), indicating that this was not likely a power concern. Further, we examined confidence as a secondary measure of semantic bias (for which we received a 100% response rate), and there was no significant relationship between these measures and semantic bias. Because this semantic bias is a fairly novel construct, perhaps increasing sample size to account for a small effect size would be a valuable strategy for maximizing statistical power in the future.

One methodological limitation lies in the implementation of the affective memory task. The paradigm was designed to examine positively, negatively, and neutrally valenced stimuli as a means of increased experimental control by manipulating affect within the laboratory. However, in examining responses to positive stimuli alone, this reduced the number of trials we were able to analyze. This may have introduced greater variability in our reaction time measurement, and certainly in our accuracy data. Because we were primarily interested in responses to positively valenced stimuli, a number of trials were not utilized. Future research

should consider a greater number of targets and lures in the positively valenced condition rather than fewer trials across valence conditions. This may result in greater power and would make possible alternative analyses, including accuracy or discriminability measures.

A final limitation lies in our analyses of semantic bias and quality of life. Our results indicated that semantic bias was related time spent on various activities. This measure of quality of life provides a practical measure of time spent within a given day. However, because the measure is designed to measure practical indicators of quality of life and because this measure did not examine engagement in or enjoyment of these activities, it is difficult to draw conclusions from this measure. Future research may seek to examine the relationship between semantic biases and the level of pleasure obtained through these various activities.

#### **4.5 Implications and Future Directions**

Anhedonia is a core symptom of schizophrenia with particularly deleterious outcomes (Horan et al., 2006). Despite its chronic and disabling course, however, neither pharmacological nor psychosocial treatments have been effective in providing symptom remission from anhedonia (Strauss, 2013b) or other negative symptoms more generally (Carpenter, Heinrichs, & Alphas, 1994). Moreover, as in other negative symptoms, anhedonia persists across the duration of the disorder (Herbener & Harrow, 2004), manifesting prior to the emergence clinically diagnosable psychotic symptoms (Blanchard et al., 2011), and persisting across the course of treatment (Pogue-Geile & Harrow, 1985).

Researchers have worked to understand anhedonia with variable success, leading recent theorists to propose a model of anhedonia in schizophrenia spectrum disorders in which self-reported symptoms of anhedonia are a product of biases in semantic knowledge networks, coupled with a set of negative pleasure-related beliefs. Given the chronic and debilitating nature

of anhedonia in schizophrenia spectrum disorders, the current study sought to examine the accessibility model of emotional self-report in order to explore the boundaries of the model and its relevance in a group of generally high-functioning individuals with elevated scores on a psychometric measure of schizotypy. Results supported this model when examining disorganized symptoms of schizotypy only. This model was not supported in total schizotypy scores or in positive or negative facets of schizotypy. Further research into the use of the accessibility model and its utility across the schizophrenia spectrum is warranted.

Schizotypy has been conceptualized as dimensional (Kwapil et al., 2008), as well as taxometric (Rawlings et al., 2008), respectively. While our measure of difference scores was a significant mediator variable for disorganized schizotypy, examining reaction times without respect to the mediating effect on schizotypy and state anhedonia may be of conceptual interest in schizotypy as a whole. A set of exploratory analyses (summarized in Appendix C) indicated that there were significant differences in the discrepancy between targets and lures in individuals high in overall schizotypy and controls. Individuals with psychometrically defined schizotypy evidenced some significant differences in their responses to positive semantically related targets and lures. There was a larger discrepancy in reaction times between targets and lures for individuals with schizotypy than in controls, suggesting that individuals with schizotypy required more time to fully process lures. Future research may seek to expand upon this preliminary analysis by examining taxometric differences between schizotypy and controls in semantic bias.

Another avenue for future research includes the addition of electroencephalography (EEG) paradigms to identify the neural correlates of semantic and episodic systems, respectively. EEG is a particularly well-equipped system for this question, as it features the necessarily high temporal resolution in measurement of brain activity required for measurement of these discreet

knowledge systems (Teplan, 2002). Research on semantic and episodic memory has utilizing electroencephalography paradigms indicates that these systems are clearly discernible based upon brain activity in the alpha, theta, and gamma bands (Zion-Golumbic, Kutas, & Bentin, 2010). Further, evidence of semantic abnormalities has been demonstrated in electrophysiological studies of semantic priming (Kiang, Prugh, & Kutas, 2010). Abnormalities in semantic priming have been correlated with increased event-related negativity in healthy controls (McPherson & Holcomb, 1999). An additional avenue for further research might include a paradigm in which individuals with schizotypy are required to complete tasks examining affective stimuli in semantic and episodic networks while collecting alpha, theta, and gamma frequencies of brain activation.

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## APPENDIX A. SCHIZOTYPAL PERSONALITY QUESTIONNAIRE – BRIEF REVISED (SPQ-BR)

INSTRUCTIONS: Please read the following statements and answer them as honestly as possible, giving only your own opinion of yourself. Do not skip any items and answer them as honestly as possible, giving only your own opinion of yourself. When thinking about yourself and your experiences, do not count as important those attitudes, feelings, or experiences you might have had only while under the influence of alcohol or other drugs (e.g., marijuana, LSD, cocaine).

Each item is rated according to the following scale:

Strongly Disagree (1)      Disagree (2)      Neutral (3)      Agree (4)      Strongly Agree (5)

### Positive symptoms:

#### Ideas of Reference

Do you sometimes feel that people are talking about you?

Do you sometimes feel that other people are watching you?

When shopping do you get the feeling that other people are taking notice of you?

#### Suspiciousness

I often feel that others have it in for me.

Do you sometimes get concerned that friends or co-workers are not really loyal or trustworthy?

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

#### Magical Thinking:

Do you believe in telepathy (mind-reading)?

Do you believe in clairvoyance (psychic forces, fortune telling)?

Have you had experiences with astrology, seeing the future, UFO's, Magical Thinking ESP, or a sixth sense?

Have you ever felt that you are communicating with another person telepathically (by mind-reading)?

#### Unusual Perception:

I often hear a voice speaking my thoughts aloud.

When you look at a person or yourself in a mirror, have you ever seen the face change right before your eyes?

Are your thoughts sometimes so strong that you can almost hear Unusual them?

Do everyday things seem unusually large or small?

#### Negative symptoms:

##### Constricted Affect:

I tend to keep my feelings to myself.

I rarely laugh and smile.

I am not good at expressing my true feelings by the way I talk and look.

##### No Close Friends

Do you feel that you cannot get "close" to people?

I find it hard to be emotionally close to other people.

Do you feel that there is no one you are really close to outside of your immediate family, or people you can confide in or talk to about personal problems?

##### Social Anxiety

Do you often feel nervous when you are in a group of unfamiliar people?

I get anxious when meeting people for the first time.

I feel very uncomfortable in social situations involving unfamiliar people.

I sometimes avoid going to places where there will be many people because I will get anxious.

Disorganization symptoms:

Eccentric Behavior

I am an odd, unusual person.

I have some eccentric (odd) habits.

People sometimes comment on my unusual mannerisms and habits.

Other people see me as slightly eccentric (odd).

Odd Speech

I sometimes jump quickly from one topic to another when speaking.

Do you tend to wander off the topic when having a conversation?

I often ramble on too much when speaking.

I sometimes forget what I am trying to say.

**APPENDIX B. AFFECTIVE MEMORY TASK STIMULI TAKEN FROM THE ANEW  
DATABASE**

Activate	Month
Alive	Murderer
Bankrupt	Mutilate
Barrel	Name
Clock	Name
Cozy	Pencil
Debt	Pencil
Defeated	Poverty
Elegant	Rape
Elegant	Reward
Errand	Savior
Failure	Slaughter
Foot	Stiff
Health	Stove
Innocent	Unit
Life	Victim
Loser	Violent
Lottery	Wealthy

## APPENDIX C. IRB EXEMPTION APPROVAL

### ACTION ON EXEMPTION APPROVAL REQUEST



**TO:** Alex Cohen  
Psychology

**FROM:** Dennis Landin  
Chair, Institutional Review Board

**DATE:** March 4, 2015

**RE:** IRB# E4922

**TITLE:** Investigating changes in student engagement during university physical activity courses

Institutional Review Board  
Dr. Dennis Landin, Chair  
130 David Boyd Hall  
Baton Rouge, LA 70803  
P: 225.578.6692  
F: 225.578.5983  
[irb@lsu.edu](mailto:irb@lsu.edu) | [lsu.edu/irb](http://lsu.edu/irb)

**New Protocol/Modification/Continuation:** Modification

**Brief Modification Description:** Adding psychophysiology recording and Electro-Encephalography

**Review date:** 3/3/2015

**Approved**  **Disapproved**

**Approval Date:** 3/3/2015 **Approval Expiration Date:** 1/21/2018

**Re-review frequency:** (three years unless otherwise stated)

**LSU Proposal Number** (if applicable): \_\_\_\_\_

**Protocol Matches Scope of Work in Grant proposal:** (if applicable) \_\_\_\_\_

**By:** Dennis Landin, Chairman 

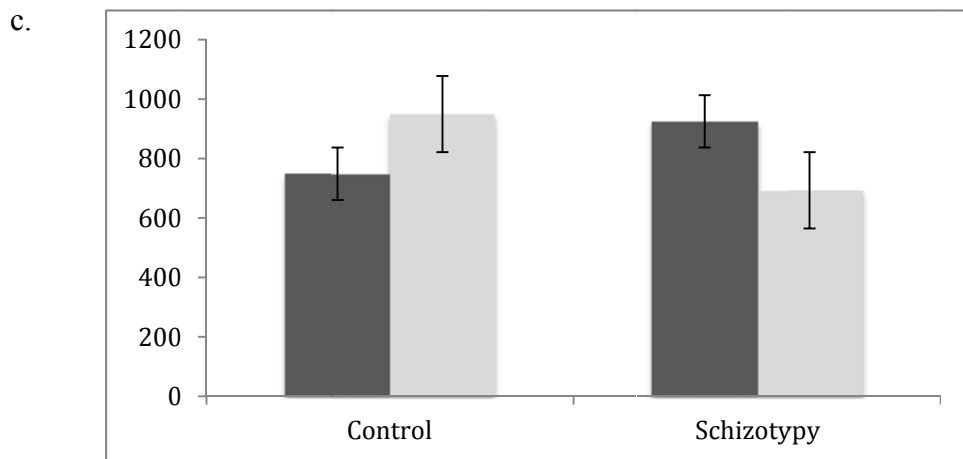
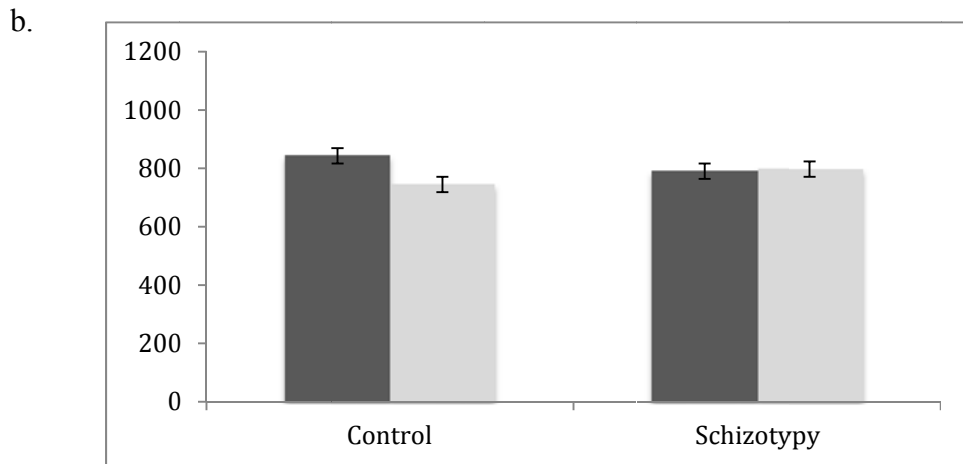
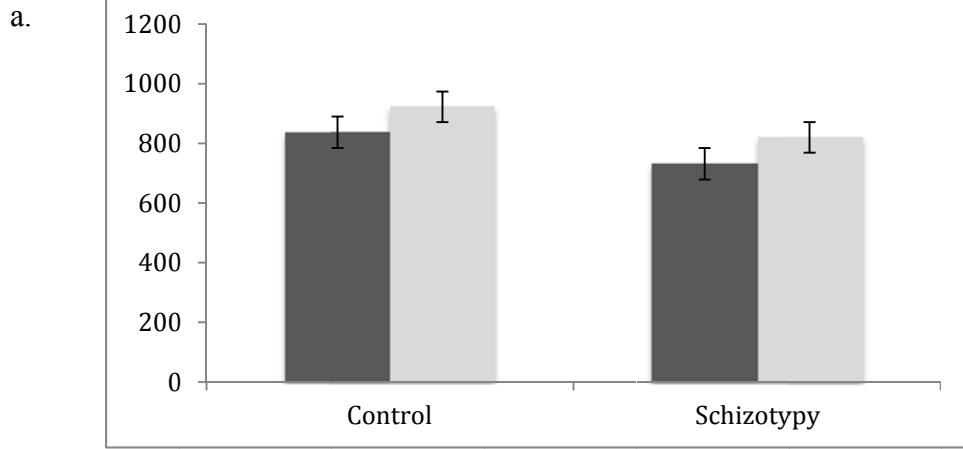
**PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –**  
Continuing approval is **CONDITIONAL** on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects\*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. SPECIAL NOTE:

\*All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at <http://www.lsu.edu/irb>

**APPENDIX D. GROUP ANALYSES EXAMINING POSITIVE (A.), NEGATIVE (B.), AND NEUTRAL (C.) CONDITIONS.**

Dark grey represents targets; light grey represents false targets



## VITA

Kyle Robert Mitchell is a third year student in the clinical psychology program at Louisiana State University (LSU), where he anticipates earning a Doctor of Philosophy in Psychology under the mentorship of Dr. Alex Cohen. Mr. Mitchell received his bachelors of Science degree from the University of Texas at Austin in 2012, graduating cum laude. During his senior year at the University of Texas, he completed his honors thesis under the supervision of Dr. Raymond Hawkins examining the importance of aberrant salience on visual attention to social stimuli. In his time at LSU, Mr. Mitchell has further refined his interests in how neurocognitive functioning affects emotional and social functioning in individuals with schizophrenia, with particular interest in how attention and memory functioning affect self-reported and real-life emotional experience.