EPISODIC MEMORY DISTORTIONS IN INDIVIDUALS PRONE TO PSYCHOSIS

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For their extraordinary support, I dedicate this research to my mother and father.

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ABSTRACT

The purpose of the present study was to determine whether individuals that exhibited a high frequency of episodic memory distortions had elevated psychosis symptoms. A comprehensive review of past literature revealed a neurocognitive relationship between schizophrenia spectrum disorders, memory impairments, and frontal lobe functioning. In addition, previous research explored the formation of memory distortions based from wordlists and picture tasks. Subsequently, an original measure called the Memory Distortion Questionnaire was created to classify 50 participants as having a high (High Distortion) or low (Low Distortion) frequency of experiencing memory distortions. The primary hypothesis of this study examined whether individuals within the HD group had increased scores on measures of psychosis compared to the LD group. Statistically significant results from an ANOVA supported expectations of the primary hypothesis. Also, two secondary hypotheses were constructed to assess differences in executive and hemispheric functioning between groups, but no statistically significant results were found.

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CHAPTER I

INTRODUCTION

Overview

Episodic memory can be considered a unique component of long term recall that is essential for remembering past events. Initially, this form of memory was believed to only consist of perfectly stored spatial events that could be automatically retrieved (Tulving & Donaldson, 1972). However, the notion of memory consisting of perfectly stored spatial events would be challenged by evidence regarding the use of misinformation to induce episodic memory errors (Loftus, et al., 1989). Eventually, the phenomenon of memory distortions would be seen as a distinct type of memory error that could even affect a broad range of individuals.

Based on common neurocognitive mechanisms, individuals who exhibit symptoms of psychosis may be one group that is more prone to memory distortions. For instance, individuals with schizophrenia exhibit increased spatial memory deficits and false recognition errors that occur at an exceedingly high prevalence (Park, 1999; Moritz, Woodward, Cuttler, Whitman & Watson, 2004). The possibility does exist that memory distortions may also be found in individuals who exhibit symptoms of psychosis, but do not meet the criteria for a diagnosis of a psychotic disorder. However, there has been very little research reported investigating this possibility. Therefore, a comprehensive study is necessary to investigate the possible relationship between memory distortions and psychosis proneness for individuals not diagnosed with a clinical disorder.

Memory Distortions in Nonclinical Populations

Research has indicated that misleading information can cause the formation of false episodic memories known as memory distortions (Loftus & Pickrell, 1995). Loftus and Pickrell (1995) found that 29% of participants recalled being lost in a mall, as a child, after being misled from a fabricated story provided by their relatives. According to Loftus (2004), even implausible false memories can be "recalled" due to misleading information. Implanted false memories can even include imagined sensory detail despite the implausibility of the recalled event (Loftus, 2004). For example, Loftus, Donders, Hoffman and Schooler (1989) created a study that used 79 sequential pictures of a burglary, which contained 4 critical images that would deliberately be misrepresented. It was found that participants were more likely to believe that false events had occurred after being presented misleading information about a staged scene (Loftus et al., 1989). Loftus et al. (1989) also determined that misleading information presented on a questionnaire was more confidently held by participants compared to the original depicted event. The implications of these studies show that even individuals not diagnosed with a clinical disorder can be prone to creating memory distortions within controlled environments.

Interestingly, early research of false memories identified group differences regarding the creation of memory distortions. Loftus, Levidow and Duensing (1992) used a short video depicting a sequence of events to test the accuracy of an individual's memory after the introduction of misinformation. Due to inaccurate responses, it was found that both children and elderly adults were susceptible to being misled by false information (Loftus et al., 1992). This suggests that memory distortions can be elicited in a similar manner by individuals within different age groups.

According to Patihis et al. (2013), the use of misinformation in wordlist tasks and photographic slideshows can elicit false memories from individuals not diagnosed with a clinical disorder. Patihis et al. (2013) utilized several associative word lists along with misleading narratives and fabricated news events, which were presented to participants through interviews and questionnaires. Results indicated that even individuals with superior autobiographical memory can be prone to creating false memories, due to post event misinformation (Patihis et al., 2013). Evidence from this study indicates that memory distortions can occur for individuals with a broad range of memory abilities.

Whereas research has supported the existence of memory distortions across age groups and memory abilities, other research has examined the relationship between memory distortions and different cognitive functions. Roediger and McDermott (1995) found that individuals can be misled to remember non-presented words from previously studied lists of words. Source monitoring deficits may be the cause of memory distortions that occur from word list paradigms (Smith, Tindell, Pierce, Gilliand & Gerkens, 2001). Studies have considered source monitoring to comprise of an individual's ability to determine the validity of retrieved episodic memories (Goff & Roediger, 1998; Smith et al., 2001). Also, source monitoring deficits can elicit illusory recollections due to repeated imagining of specific behaviors (Goff & Roediger, 1998). Overall, these studies have indicated that individuals are susceptible to creating memory distortions, due to specific cognitive vulnerabilities.

Based on the Oxford Liverpool Inventory of Feelings and Experiences (OLIFE-B), unusual experiences measures hallucination proneness, while cognitive disorganization is associated with negative symptoms of schizophrenia (Saunders, Randell, Reed, 2012). Saunders

et al. (2012) reported that individuals who score high for unusual experiences and cognitive disorganization from the OLIFE-B are more likely to recall non-presented words from studied word lists. This susceptibility can possibly be detected in other cognitive deficits related to psychosis within nonclinical populations as well. Laws and Bhatt (2005) utilized a word list paradigm and a delusional ideation scale to reveal a tendency for nonclinical populations to create false positive judgments. In fact, healthy individuals who score high on delusional ideation have increased memory deficits (Laws & Bhatt, 2005). Woodward, Buchy, Moritz and Liotti (2007), indicate that even nonclinical populations with a susceptibility to delusional beliefs can have a bias against disconfirming evidence. This disconfirmatory bias was determined from a verbal learning memory task, which revealed that individuals are unwilling to question their own judgments despite contradicting evidence (Woodward et al., 2007). Interestingly, enduring delusional beliefs could possibly lead to the formation of episodic memory distortions (Laws & Bhatt, 2005; Woodward et al., 2007).

Memory Distortions in Clinical Populations

Analyzing memory distortions within clinical populations may offer insight into the underlying neurological origin of memory impairments. Due to interacting cognitive deficits, individuals diagnosed with a neuropsychological disorder may be more likely to exhibit memory distortions because of corresponding cerebral regions being affected. Understanding the formation of memory distortions within various neuropsychological disorders can assist in localizing the cerebral region associated with memory distortions. For example, memory distortions can be induced from excessive alcohol consumption, which may cause Wernicke Korsakoff syndrome. Wernicke-Korsakoff syndrome is known to affect medial temporal lobe

structures that are important for memory functioning as well as the frontal lobes. These induced memory distortions are known as confabulations and can be elicited from either source memory deficits or intrusive recollections (Kessels, Kortrijk, Wester & Nys, 2008). Results from a confabulation interview study found that Wernicke Korsakoff patients exhibited elevated confabulations for episodic memory questions (Borsutzky, Fujiwara, Brand and Markowitsch, 2008). Borsutzky et al. (2008) also reported that confabulations within Wernicke Korsakoff syndrome are more likely to be based on an individual's own past or present experiences. Overall, these results indicate that acute alcohol induced confabulations, which originate from temporal lobe dysfunction, can be indistinguishable from chronic memory distortions (Borutzky et al., 2008; Kessels et al., 2008).

Memory retrieval impairments and cognitive deficits that occur from confabulations also share some similarities with a wide range of symptoms expressed in schizophrenia (Gilboa, 2010). Observable symptoms of psychosis are expressed on a continuum, which can include disorganized thought process, dysfunctional affect, and negative symptoms (Malla & Payne, 2005). Unfortunately, these psychosis symptoms can lead to a poor functional outcome and a reduced quality of life (Malla & Payne, 2005). Furthermore, psychosis can be identified within a prodromal phase that occurs before a clinical diagnosis of schizophrenia (Yung & McGorry, 1996). Due to cognitive deficits and positive symptoms attributed to schizophrenia, individuals with prodromal phase psychosis could possibly be prone to creating memory distortions (Gilboa, 2010; Malla & Payne, 2005).

Recent studies have also found connections between the underlying components of memory distortions for individuals diagnosed with schizophrenia. Cognitive deficits such as

memory impairments can become significantly pronounced for individuals with schizophrenia and psychosis (Simon et al., 2007). Some studies have found that patients with schizophrenia are likely to make false recognition errors of previously seen information (Moritz et al., 2004). Moritz et al. (2004) determined that false recognition and false positive recollections from word lists were significantly higher for patients with schizophrenia. Interestingly, the influence of positive symptoms, such as delusions, can contribute to the formation of memory errors. For example, a type of source memory deficit called hindsight bias demonstrates that recently learned information can influence an individual's recall of past events. Woodward et al. (2006) observed that patients with schizophrenia displayed a disproportionately high hindsight bias after being provided newly learned information. Specifically, patients with schizophrenia were more likely to claim correct debriefed trivia answers to be their actual choice despite initially responding incorrectly (Woodward et al., 2006). Individuals with schizophrenia are also unable to distinguish between true and false memory content (Moritz, Woodward & Ruff, 2003). Moritz et al. (2003) found that delayed recollections from word association tests elicited elevated source monitoring errors from patients with schizophrenia. This suggests that source monitoring deficits can influence the content of memory distortions and be exacerbated by delusional ideation.

Cerebral Dysfunction: Episodic Memory

Episodic memory functions are supported by several areas in the cerebral cortex such as the temporal and frontal lobes (Dolan & Fletcher, 1999; Turner, Cipolotti, Yousry & Shallice, 2007). The Hemispheric-Encoding-Retrieval-Asymmetry (HERA) model was created to explain the components of episodic memory functioning based from evidence of frontal lobe asymmetries (Tulving, Kapur, Craik, Moscovitvh & Houle, 1994). An important feature of the

HERA model includes its focus on the activation of the frontal cortex during the encoding and retrieval of information (Mayes & Montaldi, 1999). Furthermore, the role of hemispheric activity within the frontal cortex provides a neuropsychological explanation of memory formation. As a result, the HERA model can be used as a framework to investigate memory distortions.

Based on the HERA model, memory distortions may be understood from the hemispheric activation of the frontal cortex. Through PET scan studies, the HERA model has demonstrated that the right prefrontal cortex facilitates episodic memory retrieval, while the left prefrontal cortex is involved in episodic encoding (Nyberg, Cabeza, & Tulving, 1996). Since a portion of episodic memory functioning can be localized through the HERA model, the consequences of dysfunction to specific areas may provide insight about memory outcome. Investigating the hemispheric impairments of the frontal lobes is essential to distinguish memory distortions as a unique recollection deficit within non-clinically diagnosed populations.

The negative effects of temporal lobe dysfunction can be utilized to distinguish symptoms associated with memory distortions. Dolan and Fletcher (1999) indicated that the medial temporal lobes and hippocampus are necessary structures for episodic encoding and retrieval to occur. It is suggested that without the facilitation of these temporal lobe structures, most memory functions would not occur. Also, fMRI studies have revealed that the hippocampus increases activity during the cued recall of previously seen items (Hannula, Libby, Yonelinas & Ranganath, 2013). According to some lesion studies, damage to the medial region of the temporal lobes will result in impaired recollection (Eichenbaum, Sauvage, Fortin, Komorowski & Lipton, 2012). Depending on severity, impairment caused from a temporal lobe deficit could potentially lead to more frequent memory errors and distortions of experienced events (Mayes & Montaldi,

1999). Mayes & Montaldi (1999) state that dysfunction to the medial temporal lobes can influence the consolidation of episodic information. These results suggest that memory distortions can occur from a broad range of deficits associated from the temporal lobes.

In terms of episodic memory and temporal lobe dysfunction, intrusion errors have been found to occur for individuals diagnosed with Alzheimer's disease (Barba & Wong, 1995). Rouleau, Imbault, Laframboise and Bedard (2001) indicated that individuals with Alzheimer's disease have a high pattern of verbal recall intrusions based from the Rey Auditory Verbal Learning Test (RAVLT). In fact, intrusion errors occur more frequently for individuals with Alzheimer's disease and frontal lobe dementia compared to Parkinson's disease (Rouleau et al., 2001). The prevalence of verbal intrusions within temporal lobe disorders reveals a possible localized susceptibility that may also occur for memory distortions.

Along with the temporal lobes, there are other regions of the cerebral cortex that have significant influence over episodic memory. For example, the hippocampus regulates the accuracy of memories, while the frontal lobes influence the decision making involved in recall and recognition (Kramer et al., 2005). Specifically, neuroimaging studies have identified an association between activity in the prefrontal cortex and episodic memory (Ranganath, Johnson, & D'Esposito, 2003). Ranganath et al. (2003) also found that the lateral prefrontal cortex may assist in modulating long term memory retrieval. In this capacity, the frontal lobes function to integrate episodic information so that long term memories can be recalled.

As mentioned, the frontal lobes contribute to the formation to memory distortions, which can be exacerbated by deficits in this region (Nyberg et al., 1996). Turner et al. (2007) reported that individuals with lesions of the right prefrontal cortex were more likely to have strategic

retrieval deficits and verbal recall intrusions. These results reveal similar deficits associated with memory distortions, such as recalling false information from previously experienced events. Lesion studies have also indicated that deficits to the dorsalateral prefrontal cortex can impair free recall of remote memory (Mangels, Gershberg, Shimamura, & Knight, 1996). Furthermore, Mangels et al. (1996) and Turner et al. (2007) suggest that the dorsalateral prefrontal cortex is instrumental in the process of retrieving long term memories and creating false recollections. Evidence from these studies details the dynamic influence of frontal lobe dysfunction on the retrieval of episodic memories for the formation of memory distortions.

Cerebral Dysfunction: Schizophrenia

Understanding the mechanisms of memory distortions within schizophrenia can provide beneficial information about its formation in psychosis prone individuals. Results from many studies have indicated frontal and temporal lobe deficits, which may lead to reduced memory functioning for patients with schizophrenia. The temporal lobes and hippocampus have an important role in the encoding of events, while the frontal lobes facilitate the judgment of memories according to factual evidence (Kramer et al., 2005). In one study, Obiols et al. (1997) utilized neuropsychological assessments to measure frontal lobe functioning for individuals with psychosis symptoms, which included the Wisconsin Card Sorting Test (WCST), Trail Making Test (TMT), and a word generation test. It was found that individuals with psychosis had reduced frontal lobe functioning and experienced cognitive disturbances (Obiols et al., 1997). Moreover, frontal and temporal lobe abnormalities have also been found in individuals experiencing prodromal phase psychosis (Keshavan, Berger, Zipursky, Wood & Pantelis 2005). Further evidence from recent imaging studies reveal reduced cortical thickness in both the

temporal and frontal lobes of individuals diagnosed with a schizophrenia spectrum disorder (Oertel-Knochel et al., 2013).

Studies have indicated a broad range of memory and cognitive deficits that can be associated with frontal and temporal lobe dysfunction. For example, Oertel-Knochel et al. (2013) found that deficits within specific temporal and frontal areas can predispose an individual to severe psychosis symptoms. In addition, spatial working memory deficits are apparent for individuals with psychosis (Park, 1999). Park (1999) found that decreased spatial representation in patients with schizophrenia is mediated by deficits within the left dorsalateral prefrontal cortex. Also, individuals with schizophrenia are more likely to have elevated delta activity within the frontal lobes, which can lead to an increased risk of cognitive impairments (Winterer et al., 2000). Evidence from these studies show that cerebral dysfunction is prevalent in schizophrenia and can possibly precipitate the onset of cognitive deficits related to memory.

The interaction between cerebral dysfunction and cognitive deficits in schizophrenia may also be applied to individuals with symptoms of psychosis. Since frontal lobe dysfunction enhances psychosis symptoms, memory distortions could be a subsequent deficit (Obiols et al., 1997; Simon et al., 2007). Because psychosis symptoms exist on a continuum, it is possible that memory distortions occur at a similar prevalence for individuals not clinically diagnosed.

Cerebral Dysfunction: Schizotypal Traits

Individuals with schizophrenia and schizotypal traits have been found to share certain cerebral deficits, which may reveal a common occurrence of memory distortions. Because of this, distinguishing schizotypal personality traits within a general population is relevant for investigating the interaction between psychosis symptoms and memory distortions. Also,

neuropsychological tests reveal similar left temporal and prefrontal lobe dysfunction for individuals diagnosed with schizotypal personality disorder compared to schizophrenia (Voglmaier et al., 1997). To support these findings, recent MRI studies have found that individuals with schizotypal personality traits have half the reduced gray matter volume within the temporal and frontal lobes compared to schizophrenia patients (Hazlett et al., 2008). Therefore, understanding frontal and temporal deficits related to both schizotypal personality traits and schizophrenia can assist in finding the prevalence of memory distortions for undiagnosed individuals.

The eccentric behavior and odd beliefs characterized in schizotypal personality traits may indicate less severe cerebral dysfunction compared to schizophrenia (Voglmaier et al., 1997; Siever et al., 2002). Furthermore, the genetic relationship that exists within schizophrenia spectrum disorders may indicate an increased likelihood for individuals with schizotypal traits to form memory distortions (Siever et al., 2002). Due to this genetic relationship, cognitive deficits in working memory, verbal learning, and attention are more pronounced for individuals with elevated schizotypal traits (Siever at al., 2002). In particular, Hubbard et al. (2015) recently found that a significant genetic overlap exists between cognition and schizophrenia in terms of performance IQ. Based on the HERA model, the left hemispheric dysfunction seen in schizotypal personality traits can indicate impairments in episodic memory encoding (Nyberg, Cabeza, & Tulving, 1996; Voglmaier et al., 1997). Overall, research indicates that elevated schizotypal personality traits share similar neurocognitive deficits with schizophrenia, which can produce memory distortions.

Limitations of Previous Research and Purpose of Current Study

The purpose of this study is to determine if a relationship exists between memory distortions and psychosis proneness for individuals not diagnosed with a clinical disorder. This is attributed from the various forms of memory distortions found by previous studies (Loftus & Pickrell, 1995; Roediger & McDermott, 1995). Also, there have been schizotypal personality studies which investigated spatial working memory deficits for undiagnosed healthy individuals (Park & McTigue, 1997). The significance of these results suggests a convergence of symptoms between schizophrenia and schizotypal traits (Park & McTigue, 1997). However, there is a lack of current research to investigate episodic memory distortions from individuals who exhibit psychosis symptoms.

Previous episodic memory investigations neglected to focus primarily on the personally experienced events of an individual. Instead, these past studies repeatedly utilized word lists, pictures, and videos to measure memory distortions (Loftus et al., 1989; Roediger & McDermott, 1995; Patihis et al., 2013). These common research methods can contribute significant empirical results, but they neglect to measure episodic memory from an individual's immediate surrounding observations. In order to create false memories, past studies have also relied too heavily on excessive deception or extended delayed response intervals, which can lead to frustrating participants (Goff & Roediger, 1998). Despite similar results being published, the definition of memory distortions has been continually altered, which has created less of an emphasis on recognizing an individual's subjective recollections. Consequently, this dilemma has presented a unique opportunity to improve upon previous research about specific populations prone to creating memory distortions.

Unlike previous investigations, this study will introduce an original measure called the Memory Distortion Questionnaire (MDQ), which distinguishes items associated with memory errors and memory distortions. More importantly, the MDQ can be used to categorize individuals based on their distortion proneness. The MDQ will utilize the immediate surroundings of participants in order to measure their episodic memory functioning and susceptibility to recall false memories. Both neuropsychological and psychosis measures will be administered to determine if individuals susceptible to creating memory distortions have elevated scores on these tests. Thus, this study's goal will be to utilize the Memory Distortion Questionnaire as a new method of measuring memory distortions, while assessing the interaction of misleading information on psychosis proneness and executive functioning.

Summary and Hypothesis

According to previous research, individuals not diagnosed with a clinical disorder are susceptible to creating memory distortions due to false information (Loftus, 1992; Loftus & Pickrell, 1995). Based on the HERA model, cerebral dysfunction within the right prefrontal cortex can significantly impair episodic memory retrieval (Nyberg, Cabeza, & Tulving, 1996). Also, recent trends in schizophrenia research have indicated a possible relationship between the severity of memory impairments and prodromal phase psychosis (Simon et al., 2007). The interaction between executive functioning, psychosis, and episodic memory is consistent with the HERA model framework regarding the activation of the prefrontal cortex during encoding and retrieval (Nyberg, Cabeza, & Tulving, 1996; Simon et al., 2007). As a result, this evidence presents an opportunity to investigate the neuropsychological functioning of individuals likely to both create memory distortions and endorse elevated symptoms of psychosis.

For this study, a primary hypothesis and two secondary hypotheses were tested in relation to memory distortions in populations with elevated psychosis symptoms. The primary hypothesis predicts that individuals that exhibit memory distortions are more likely to have elevated total scores for measures of psychosis symptoms. The first secondary hypothesis predicted that individuals exhibiting memory distortions would have overall reduced executive functioning on neuropsychological assessments. Based on hemispheric functioning, the second secondary hypothesis suggested that individuals with pronounced memory distortions have prominent right frontal lobe dysfunction compared to the left frontal lobe. Scores from both neuropsychological and psychosis measures were compared based on differences between a high and low memory distortion group. Overall, these hypotheses distinguish individuals vulnerable to creating episodic memory distortions based on their assessed neurocognitive functioning.

CHAPTER II

METHOD

Participants

Participants for this study included fifty undergraduate students (Female = 35, Male = 15) recruited from Middle Tennessee State University. The ages of the participants ranged from 18 to 33 years (M = 22.00, SD = 4.19) (see Table 1). Students were selected from the university research pool and awarded class credit for their participation. As will be described in the Results section, exclusionary criteria were used for some statistical analyses. These exclusionary criteria included being clinically diagnosed with any psychological illness, neurological disorder, or head injury. Also included was use of recreational drugs or psychotropic medication.

Psychosis Questionnaires

Perceptual Aberration Scale (PAS). The Perceptual Aberration Scale (PAS) is a 35-item self-report questionnaire that measures aberrant body image and perceptual distortions (Chapman, Chapman, & Raulin, 1978). The PAS was created to identify various positive symptoms associated with schizophrenia, such as body image aberration and differentiate them from other perceptual hallucinations (Chapman et al., 1978). Chapman et al. (1978) developed the PAS due to deviant bodily perceptions being common in schizophrenia. It was used to measure psychosis symptoms in the current study.

On the 35-item PAS, each item requires a “true” or “false” response that is scored as either 0 or 1 (Chapman et al., 1978). In order to detect body image aberration, 31 items are keyed as “true” and 4 items are reverse keyed as “false”, which are both scored as 1 point

(Chapman et al., 1978). The total PAS score ranges from 0 to 35 and consists of the combined ratings from all 35 items (Chapman et al., 1978).

An important strength of the PAS relates to its consistent reliability and validity. In terms of reliability for body image aberration, college students have a coefficient alpha between .88 and .90 (Chapman, Chapman, & Miller, 1982). The PAS test-retest reliability was also found to be between .75 and .76 (Chapman et al., 1982). For validity, the PAS has a .70 correlation with the Magical Ideation Scale, which supports that its 35 items are a representation of positive psychotic symptoms (Chapman et al., 1982). As a research measure, the PAS can be considered appropriate for identifying psychosis proneness based on acceptable reliability and validity data. The dependent variable of this measure will be the total score from each item.

Peters Delusions Inventory (PDI). The Peters Delusions Inventory (PDI) is a 40-item self-report questionnaire designed as a multidimensional measure of delusional ideation within nonclinical populations (Peters et al., 1999). A 21 item version of the PDI was later created to identify three core factors of delusional ideation, which include distress, preoccupation, and conviction (Peters et al., 2004). For this study, the 21 item PDI was utilized for identifying participants reported level of delusional ideation.

On the 21-item PDI, four separate subscales are obtained: a PDI yes/no score, a distress score, a preoccupation score, and a conviction score (Peters et al., 2004). Each item is answered with a yes/no response and a five point rating scale (Peters et al., 2004). Scores for the PDI yes/no score range from 0 to 21, while the distress, preoccupation, and conviction scores range from 0 to 5 for each item (Peters et al., 2004). A total PDI score can be calculated by combining the four subscales, with ranging scores from 0 to 336 (Peters et al., 2004).

Psychometric data for both the 40-and 21-item PDI has indicated high reliability and validity. Based on psychometric testing, the PDI has very good internal consistency, with a Cronbach's alpha of .82 (Peters et al., 2004). Test-retest reliability reveals significant relationships between the first and second administrations of the 21 item PDI, which includes PDI yes/no: Spearman's $r = .78$, $n = 83$, $p < .001$; Distress: Spearman's $r = .81$, $n = 74$, $p < .001$; Preoccupation: Spearman's $r = .81$, $n = 76$, $p < .001$; Conviction: Spearman's $r = .78$, $n = 70$, $p < .001$ (Peters et al., 2004).

Validity data for the PDI also demonstrates high statistically significant relationships. Due to a significant correlation between the PDI and the Delusions Symptoms State Inventory (DSSI), convergent validity is evident (Spearman's $r = .61$, $n = 327$, $p < .001$) (Peters et al., 2004). Discriminant validity was based on the PDI being correlated with only positive symptom scales of schizophrenia (Schizotypal Personality Scales: Spearman's $r = .51$, $n = 47$, $p < .001$; Unusual Experiences factor: Spearman's $r = .65$, $n = 47$, $p < .001$; Impulsive Nonconformity factor: Spearman's $r = .37$, $n = 47$, $p = .01$) (Peters et al., 2004). Criterion validity for the PDI was determined by the significantly elevated scores from clinical participants compared to nonclinical participants (Peters et al., 2004). The dependent variable was the total raw score from the four subscales. For the purpose of this study, only the total PDI score was used for analysis, because it represents a global measure of delusional ideation.

Schizotypal Personality Questionnaire-Brief (SPQ-B). The Schizotypal Personality Questionnaire-Brief (SPQ-B) is a 22-item self-report questionnaire developed to screen for elevated schizotypal traits in nonclinical populations (Raine & Benishay, 1995). Within the SPQ-

B, three subscales are used to measure symptoms of schizotypal personality disorder: Cognitive Perceptual deficits, Interpersonal deficits, and Disorganization (Raine & Benishay, 1995).

On the 22-item SPQ-B, each item is answered as either "yes" or "no", which is then assigned a respective score of 1 or 0 (Raine & Benishay, 1995). A total SPQ-B score ranging from 0 to 22 consists of the combined scores from all three schizotypal symptom subscales (Raine & Benishay, 1995).

Psychometric data for the SPQ-B subscales indicate strong reliability and validity. The internal reliability of the SPQ-B ranges from .72 to .80 and has a mean of .76 (Raine & Benishay, 1995). After a two month delay, test-retest reliability for the SPQ-B was between .86 and .95. ($p < .001$), with a mean of .90 (Raine & Benishay, 1995). Criterion validity was determined by comparing the SPQ-B with three schizotypal personality dimensions from a diagnostic interview, which have a correlation between .34 to .73 and a mean of .62 (Raine & Benishay, 1995). The psychometric data of the SPQ-B reveals why this measure continues to be broadly used within clinical research. The dependent variable was the total raw score attained from all 22 items. For this study, the SPQ-B will be an additional component for identifying psychosis proneness.

Neuropsychological Assessments

Animal Naming. Animal Naming was developed as a neuropsychological measure of semantic fluency through the production of animal words within sixty seconds (Strauss, Sherman, & Spreen, 2006). Because Animal Naming is a verbal fluency test, it was designed to measure an individual's ability to verbally associate words based from a specific category

(Strauss et al., 2006). For this study, Animal Naming will be utilized to assess executive functioning.

Administration of the Animal Naming verbal fluency test requires the generation of as many words from the category "animals" within 60 seconds (Tombaugh et al., 1999). Once 60 seconds has elapsed, a total Animal Naming (Semantic) score is determined (Tombaugh et al., 1999). Specifically, the total number of animal words produced by the participant will be considered the dependant variable. In terms of psychometric data for Animal Naming, the semantic fluency category has been found to positively correlate with the vocabulary section of the Wechsler Adult Intelligence Scale-Revised (WAIS-R) (Tombaugh et al., 1999).

Controlled Oral Word Association Test (COWAT). The Controlled Oral Word Association Test (COWAT) was developed as a neuropsychological measure of phonemic fluency through the spontaneous production of words within sixty seconds (Strauss, Sherman, & Spreen, 2006). As a verbal fluency test, the COWAT was designed to measure an individual's verbal association with specific letters (Strauss, Sherman, & Spreen, 2006). For this study, the FAS version of the COWAT was administered to assess verbal fluency.

Administration of the COWAT requires the generation of as many words from the letters F, A, and S within 60 seconds (Tombaugh et al., 1999). Repetitions, proper nouns, and the same word with different suffixes are not allowed (Tombaugh et al., 1999). After the completion of each verbal fluency section, a total FAS (Phonemic) score is determined by adding the number of words generated for each letter (Tombaugh et al., 1999).

Normative and psychometric data for verbal fluency have been updated through several studies, which have reported reliable results. For the internal consistency, the letters F, A, and S

have high item homogeneity, with a coefficient alpha of $r = .83$ (Tombaugh et al., 1999). Test-retest reliability for the phonemic category of verbal fluency is considered within acceptable limits, $r = .74$, $p < .001$ (Tombaugh et al., 1999). The total score was used as a dependent measure in the current study.

Memory Distortion Questionnaire (MDQ). Due to the shortcomings of available research methods to assess memory distortions, an original measure of episodic memory distortions was developed for this study. The Memory Distortion Question (MDQ) was created in an effort to identify the presence of memory distortions and assess episodic memory functioning (see Appendix B). The MDQ consists of episodic recognition questions related to the recollection of objects and activities experienced by each participant during the study. These recollection based questions were influenced from evidence that prominent spatial working memory deficits can occur from psychosis (Park, 1999; Rudebeck, 2012). After the introduction of misleading information, items related to episodic recognition were constructed in response to the formation of false memories (Loftus, 2004; Loftus et al., 1989). Because the MDQ is an original measure, psychometric data are not currently available. Despite this limitation, the MDQ fulfills its role for the current study by assessing potential episodic memory distortions from a unique investigative approach.

The Memory Distortion Questionnaire was constructed as a 24 item assessment that can be administered in the form of a brief interview. This questionnaire consists of 12 misleading questions and 12 factual questions which were designed to distinguish impairments within episodic memory. For example, misleading items present two choices for participants to select regarding an event that did not occur. A specific misleading item in the MDQ asks, “Were the

math questions easy or difficult?", despite math questions not being present in any assessment. In contrast, factual items in the MDQ are designed to test participants' ability to recall either a true or false event without the influence of misinformation (i.e., "Did I ask for your home address or email address for the purpose of the study?"). Therefore, differences between misleading and factual items are crucial for indicating the presence of memory distortions.

In terms of scoring the MDQ, both misleading and factual items were scored according to each participant's response. If a misleading question was answered incorrectly, 1 point was recorded for that item. For instance, an incorrect misleading response includes participants recalling a distorted memory from events that did not occur. Likewise, based from a false response, factual questions answered incorrectly were scored as 1 point. Each set of misleading and factual items are separated as two scales ranging between 0 to 12 points. For the purpose of this study, misleading item scores were considered the primary dependent variable, and factual item scores were utilized as a supplemental covariate. Accordingly, high scores for misleading items will indicate a presence of memory distortions, while high scores for factual items reveal potentially impaired memory functioning.

Ruff Figural Fluency Test (RFFT). The Ruff Figural Fluency Test (RFFT) is a neuropsychological measure of the production of novel designs created within time constraints (Ruff, Light & Evans, 1987). The RFFT was designed to measure nonverbal fluency, which is analogous to verbal fluency tests that assess executive functioning, such as the COWAT and Animal Naming (Ross, 2014). According to Ruff, Allen, Farrow, Niemann & Wylie (1994), the RFFT is sensitive to right frontal lobe functioning. In fact, it has been found that low fluency scores on the RFFT indicate decreased right frontal activity based from increased delta activity

(Foster, Williamson & Harrison, 2005). Because the RFFT has an estimated administration time of ten minutes, it can be considered a brief measure of nonverbal fluency (Ruff et al., 1987).

The RFFT consists of five separate parts that contain a different stimulus pattern (Ruff et al., 1987). For each pattern, individuals connect dots to draw unique designs while attempting not to repeat what had been previously drawn (Ruff et al., 1987). The total number of designs created within a 1 minute interval is considered the Nonverbal Fluency score (Ruff et al., 1987). For this study, the total number of unique designs created was used to assess right frontal lobe functioning.

Reliability and validity for the RFFT has been consistent based from its broad use in neuropsychological research. Test-retest reliability over a twelve month period for the RFFT is reportedly between .71 - .88 (Ruff et al., 1987). The RFFT inter-rater reliability also has been found to be between .80 - .98 (Ross, Foard, Hiott & Vincent, 2003). Convergent validity for the RFFT between other figural fluency tests is modestly correlated, but it is less consistent with phonemic fluency tests compared to semantic fluency (Ruff et al., 1987). These psychometric results reveal that the RFFT is an acceptable test of nonverbal figural fluency and executive functioning.

Trail Making Test (TMT). The Trail Making Test (TMT) is a neuropsychological measure of attention, speed, and mental flexibility which can be used to assess executive functioning (Strauss et al., 2006). This test requires participants to complete two line connection tasks. Part A includes connecting numbers one through twenty five, Part B alternates between connecting numbers and letters. Another important benefit of the TMT relates to its administration time,

which is estimated to take around 5 to 10 minutes (Strauss et al., 2006). Scores for TMT Part A/B are based directly from the completion time of each test (Strauss et al., 2006).

TMT is broadly used in both clinical and research settings, with evidence of strong reliability and validity data. For adults between 15-83 years old, test-retest reliability for Part A was r = .79 and r = .89 for Part B (Dikmen, Heaton, Grant & Temkin, 1999). Interrater reliability has been reported to be r = .94 for Part A and r = .90 for Part B (Fals-Stewart, 1991). In terms of validity, both Part A and Part B of the TMT correlate moderately with one another (r = .31), while measuring different functions (Heilbronner, Henry, Buck, Adams & Fogle, 1991). Based on these psychometric data, the TMT is a quick and accurate measure of executive functioning. The dependent variable for the current study was the separate raw scores from Part A and B.

Supplemental Assessments

Beck Depression Inventory-Second Edition (BDI-II). The Beck Depression Inventory-Second Edition (BDI-II) is a 21 item questionnaire designed to measure self reported depression within adolescents and adults (Beck, Steer & Brown, 1996). The time required to complete the BDI-II is between 5 to 10 minutes, and it can be self administered (Beck et al., 1996). Respondents are given a choice of four options (0-3) for each item to indicate severity of depressive symptoms (Beck et al., 1996). A total BDI-II score can range from 0 to 63, which is used to detect an overall level of depression. Therefore, the purpose of using the BDI-II in the current study was to identify depressive symptoms that may be related to test performance.

According to Beck et al. (1996), internal consistency for the BDI-II can range between r = .84 to r = .93. Test retest reliability, over a one week period, indicates high correlations between r = .93 to r = .96 (Beck et al., 1996). In terms of divergent validity, the BDI-II correlates

higher with depression measures compared to anxiety measures $r = .50$ to $r = .60$, such as the Beck Anxiety Inventory (Beck et al., 1996). Also, clinical findings have supported the accuracy of the BDI-II due to its 93% sensitivity and 18% false positive rate for identifying major depression (Beck et al., 1996).

Brief Visuospatial Memory Test-Revised (BVMT-R). The Brief Visuospatial Memory Test-Revised (BVMT-R) was designed to measure cognitive abilities associated with visual learning and memory (Benedict, Schretlen, Groninger, Dobraski & Shpritz, 1996). Excluding a delay interval, the BVMT-R can be administered within 15 minutes to individuals between ages 18 to 79 years (Benedict et al., 1996). A unique aspect of the BVMT-R relates to its focus toward assessing figural learning, which can be utilized to measure aspects of visuospatial memory functioning.

The BVMT-R consists of immediate recall, acquisition, delayed recall, and recognition trials (Benedict et al., 1996). For each trial, six geometric designs are required to be reproduced, according to location, after being presented for 10 seconds (Benedict et al., 1996). Accurately reproduced designs are awarded 2 points each, which creates a scoring range between 0 to 12 points for every trial (Benedict et al., 1996). For the purpose of this study, only the immediate recall trial of the BVMT-R was administered, because it provides an accurate overview of visual memory and learning performance.

In terms of psychometrics, the BVMT-R is considered a highly reliable and valid measure of visuospatial memory functioning. Test-retest reliability coefficients for the total recall trial was found to be $r = .80$ (Benedict et al., 1996). Furthermore, interrater reliability has been reported to be greater than $r = .90$ (Benedict et al., 1996). Regarding validity, the BVMT-R

is strongly correlated (r = .65 to .80) with the Visual Reproduction subtest of the Wechsler Memory Scale-Revised (WMS-R) (Benedict et al., 1996). Therefore, these results indicate the accuracy of the BVMT-R for measuring visuospatial recall.

Demographic Form. A 9-item demographic form was used to gather information regarding each participant's medical history (see Appendix C). Questions related to history of psychiatric illness, neurological disorder, and traumatic brain injuries were designed as a health measure for this study. Also, participants were given the opportunity to disclose demographic information pertaining to their physiology (i.e., sex, age, height, weight, handedness), education, and psychotropic medication usage (i.e., prescription or recreational). The relevance of this demographic form was to determine preexisting health issues that could confound participant performance on cognitive assessments. Conversely, demographic information provided data for supplemental analyses regarding correlations between memory distortions, executive functioning, and psychosis proneness.

Hopkins Verbal Learning Test-Revised (HVLT-R). The Hopkins Verbal Learning Test-Revised (HVLT-R) is a neuropsychological test used to assess verbal learning and memory (Brandt & Benedict, 2001). The HVLT-R contains three learning trials, a delayed recall trial, and a delayed recognition trial (Brandt & Benedict, 2001). This test has been normed to be administered within 40 minutes to individuals between 13-80 years old (Brandt & Benedict, 2001). The HVLT-R was used to assess each participant's verbal memory functioning.

The HVLT-R consists of four calculated raw scores, which include measures for total recall, delayed recall, percent retention, and a recognition discrimination index (Brandt & Benedict, 2001). Scores from each measure is converted to T scores based on specific age

categories (Brandt & Benedict, 2001). For this study, only the total recall was considered a dependent variable, since the HVLT-R was used as a supplemental measure of verbal memory functioning.

According to Benedict et al. (1998), test-retest reliability coefficients for the HVLT-R range between .39 and .74 for each trial. Alternate form reliability has been determined to be equivalent for 6 forms of the HVLT-R, but the delayed recognition trial elicited false positive responses (Benedict et al., 1998). In terms of validity, the HVLT-R correlates highly with verbal memory measures such as the WMS-R Logical Memory subtest, r = .65 to .77, and visual memory measures, r = .54 to .69 (Shapiro, Benedict, Schretlen & Brandt, 1999). These findings reveal that the results from the HVLT-R are consistent overtime and share several components with similar tests.

Procedure

Following IRB approval (see Appendix D), data collection began. When participants arrived for the first meeting, they were given a consent form by the primary investigator and asked to wait outside of the testing room. Once consenting participants came into the testing room, a demographic form, BDI-II, and psychosis questionnaires (i.e., PDI, SPQ-B, PAS) were administered. Once the initial questionnaires were completed, several neuropsychological assessments were administered (i.e., TMT, COWAT, Animal Naming, RFFT, HVLT-R, BVMT-R). All measures were administered in the same order for each participant. At the conclusion of this meeting, participants were asked to offer their email address and telephone number to facilitate administration of the Memory Distortion Questionnaire (MDQ) at a later time.

After a 7 day interval, participants were contacted for the MDQ administration through a phone interview session. Since the MDQ consists of 24 questions, the phone interview and subsequent conversation were brief. After the MDQ was administered, participants were offered an opportunity to ask questions related to the current study and then immediately debriefed regarding its overall purpose. Once all procedures were completed, course research credit was promptly awarded to each participant.

CHAPTER III

RESULTS

Initial Analysis

Two independent groups were created based on participant performance on the Memory Distortion Questionnaire (MDQ). To distinguish participants with more memory distortions, a median split based on the misleading item score was used. The misleading item scores on the MDQ ranged from 0 to 11 points (M = 5.26, SD = 2.82) for the entire sample. The median score of 5 was used to create High and Low Distortion groups. The range of scores for the Low Distortion group was 0 to 5 (M = 2.92, SD = 2.09), indicating a lower propensity for memory distortions. The range of scores for the High Distortion group was 6 to 11 (M = 7.64, SD = 3.61), indicating a greater propensity for memory distortions and influence from misleading questions. Unlike the misleading items score, the factual item score is intended to determine if either the High Distortion and Low Distortion groups significantly differ in relation to memory functioning for events that actually transpired. Unless stated otherwise, analyses for group comparisons were conducted with an alpha of (p = .05).

The possibility exists that individuals in the High Distortion group have factual memory functioning that differs from those in the Low Distortion group. To evaluate potential Low and High Distortion group differences, comparisons were made between the groups on measures of verbal and visual memory, factual memory, depression, age, and psychological illness history.

Based on a series of one-way ANOVAs, there were no statistically significant differences between the High Distortion and the Low Distortion groups for any of the indices from the HVLT-R or the BVMT-R (see Table 2). The scores from the MDQ-factual measure scale also

did not differ significantly between the High and Low Distortion groups. Further, scores from the BDI-II and the ages of the two participant groups did not significantly differ. Chi-square analysis indicate no statistically significant association between the two Distortion groups and psychological illness, $X^2(2) = 1.923$, $p = .382$. These findings indicate that the High and Low Distortion groups did not differ in regard to overall verbal or visuospatial memory functioning, memory for events of that transpired in this study, depression, age, or history of a psychological illness.

Primary Analysis

The primary hypothesis of this study predicted that the High Distortion group would endorse more psychosis symptoms on measures of psychosis compared to the Low Distortion group. Psychosis symptom endorsement was determined from elevated scores on the Schizotypal Personality Questionnaire-Brief (SPQ-B), Peters Delusions Inventory (PDI), and Perceptual Aberration Scale (PAS). To examine this hypothesis, three separate oneway ANOVAs were conducted on the total scores from the SPQ-B, PDI, and PAS (see Table 3). The results indicated a statistically significant difference existed between the High Distortion ($M = 9.76$, $SD = 4.28$) and Low Distortion ($M = 7.16$, $SD = 4.40$) groups for the SPQ-B total score, $F(1,48) = 4.497$, $p = .039$. However, there were no statically significant differences found between the groups for the PDI, $F(1,48) = 2.62$, $p = .112$, and PAS total scores, $F(1,48) = 1.39$, $p = .244$. Supplemental analyses then were conducted to examine if any group differences existed in regard to scores on the subscales of the SPQ-B and the PDI. Given the lack of a-priori hypotheses for these supplemental analyses, a Bonferoni correction was used to control for

experiment wise error rate (p = .0125). The results of these analyses indicated no significantly different group differences on any of the subscales.

It also was hypothesized was that individuals who exhibit memory distortions would have significantly lower scores on measures of executive functioning. To examine this hypothesis the High and Low Distortion groups were compared on their performance on several measures of executive functioning, including the Controlled Oral Word Association Test (COWAT), Animal Naming, Trail Making Test-A/B (TMT-A/B), and the Ruff Figural Fluency Test (RFFT). A Bonferoni correction was used to control for experiment-wise error rate (p = .01). The results of a series of one-way ANOVAs indicated no statistically significant differences between the High and Low Distortion groups for any of these measures of executive functioning (see Table 4).

Further, it was predicted that participants within the High Distortion group would have relatively greater right frontal lobe dysfunction as compared to the left frontal lobe. To examine this hypothesis scores from the COWAT and RFFT were converted to z-scores. Paired samples *t*-tests were then conducted to determine if scores on the COWAT and RFFT were significantly different. The result indicated no statistically significant difference in RFFT (M = -.88, SD = 1.37) and the COWAT (M = -.76, SD = .87) z-scores within the High Distortion group, $t(24)$ = .475, p = .639. An additional paired samples *t*-test was conducted for the Low Distortion group, but again no statistically significant difference was found between the RFFT (M = -.89, SD = 1.14) and the COWAT (M = -.63, SD = 1.02) z-scores, $t(24)$ = .863, p = .396.

Follow-Up Analysis

The primary analyses included the entire sample of 50 participants. However, some of these participants reported a history of psychological illness. The inclusion of these participants

in the analyses may have affected the findings of the neuropsychological and psychosis measures. Hence, the analyses described previously were repeated with these participants being excluded. A total of 38 participants remained after individuals with psychological illness were excluded. The sample consisted of 10 men and 28 women with an age range of 18 to 33 years (M = 21.87, SD = 4.05). A median split was used as before to create High and Low Distortion groups. Using the same median split as before (misleading items score of 5) left 18 participants in the Low Distortion group (M = 2.72, SD = 1.41) and 20 participants in the High Distortion group (M = 7.55, SD = 1.39).

As before, initial analyses were conducted to determine if the High and Low Distortion groups differed significantly in regard to memory functioning, depressive symptoms, and age. The results of a series of oneway ANOVAs indicated no statistically significant differences between the groups for the HVLT-R, BVMT-R, MDQ-Fact, BDI-II, and age (see Table 5).

Regarding the primary hypothesis, several one-way ANOVAs were conducted to determine whether psychosis measure scores for the High Distortion and Low Distortion groups had statistically significant differences within the thirty-nine participant sample. A statistically significant difference between the High Distortion (M = 9.71, SD = 4.52) and Low Distortion (M = 6.00, SD = 3.18) groups was found for the SPQ total score, $F(1,37) = 8.53$, $p = .006$. A statistically significant difference between the High Distortion (M = 86.76, SD = 51.07) and Low Distortion (M = 55.06, SD = 37.50) groups was found for the PDI total score, $F(1,37) = 4.74$, $p = .036$. No statistically significant difference could be found for the PAS. As before, a Bonferoni correction, $p = .0125$ was used for the psychosis measure subscales. Group differences on the SPQ-B cognitive-perceptual subscale was statistically significant $F(1,37) = 7.67$, $p = .009$,

but group scores for the SPQ-B disorganized, PDI distress, and PDI preoccupation subscales were not statistically significant (see Table 6).

For the secondary hypothesis, several one-way ANOVAs were conducted to determine whether executive functioning scores for the High Distortion and Low Distortion groups, excluding those with a psychological illness, had statistically significant differences. Using a Bonferoni correction ($p = .01$), there were no statistically significant differences between groups for the COWAT, Animal Naming, TMT Part A, TMT Part B, and the RFFT total scores (see Table 7).

CHAPTER IV

DISCUSSION

In terms of memory functioning, initial analyses indicated that both groups had comparable scores on standardized tests of verbal (HVLT-R) and visual (BVMT-R) memory. As a supplement to the MDQ-Misleading scale, the MDQ-Factual scale revealed that the High Distortion and Low Distortion groups were similar in distinguishing factual based episodic memories. Also, no statistically significant differences were found between groups based on a self reported measure of depressive mood (BDI-II) and age. Furthermore, a chi-square test of associations indicated that individuals with a psychological illness were equally dispersed between both comparison groups in the fifty participant sample. Thus, any observed differences between the groups on measures of psychosis and executive functioning, in both sample sizes used, are less likely to be related to the confounding effects of impaired recall or depression.

The primary results indicated a statistically significant difference between the High Distortion and Low Distortion groups for the psychosis measures, which supports the initial assumptions of the primary hypothesis. Specifically, the High Distortion group exhibited a significantly higher SPQ-B total score than the Low Distortion group. This difference in SPQ-B total score existed with both sets of analyses. In the reduced thirty-nine participant sample, the PDI total score and a subscale of the SPQ-B (i.e., cognitive perceptual) also indicated elevated scores for the High Distortion group compared to the Low Distortion group. Only the PAS revealed no statistically significant difference between groups within both the fifty and thirty-nine participant sample size. However, it deserves to be mentioned that psychosis scores for both

groups were lower than the original norm groups for each measure (Chapman et al., 1978; Peters et al., 2004; Raine & Benishay, 1995).

An unexpected outcome of the primary analysis relates to statistically significant group differences being found on the SPQ-B and PDI, while none could be detected for the PAS. Due to measuring body-image aberration, the similar group means for the PAS may be related to its usefulness for identifying individuals at a high risk for schizophrenia (Chapman et al., 1978). In contrast, the recent designs of both the SPQ-B and PDI were intended for distinguishing schizotypal traits and delusional ideation in general populations (Peters et al., 2004; Raine & Benishay, 1995). As a result, the nonclinical status of participants may have contributed to statistically significant differences, in both samples, being found for the SPQ-B and PDI, but not the PAS.

Regarding the analysis for the secondary hypotheses, there was no statistically significant difference between High Distortion and Low Distortion groups. In particular, based the COWAT, Animal Naming, TMT-A/B, and RFFT, it was found that both groups had similar neuropsychological functioning. Also, the High Distortion group did not have elevated right frontal lobe (RFFT) dysfunction compared to a measure of the left frontal lobe (COWAT). These results seem to not support aspects of the Hemispheric-Encoding-Retrieval-Asymmetry (HERA) model regarding right prefrontal retrieval and left prefrontal encoding of episodic memories (Nyberg, Cabeza, & Tulving, 1996). It may be possible that the neuropsychological tests used in the present study measure different frontal lobe regions and forms of behavior compared to the psychosis questionnaires.

Based on previous research, the present findings share some similarities with results from past investigations of memory distortions and psychosis. For instance, the MDQ accurately distinguished episodic memory distortions due to misleading information, which Loftus et al. (1989) described as a misinformation effect that induces individuals to make confidently held questionnaire responses. Likewise, using the MDQ to alter participants' recollection of their encountered surroundings was an expansion of the Roediger and McDermott (1995) application of misleading participants to remember non-presented words from previously studied wordlists.

Regarding psychosis and memory distortions, Laws and Bhatt (2005) found that healthy individuals with elevated delusional ideation created false positive judgments on wordlist paradigms. Also, Saunders et al. (2012) indicated that individuals with reported unusual experiences and cognitive disorganization would recall non-presented words from studied word lists. Consequently, these past investigations further support the findings of the current study, due to similar results on the relationship between psychosis symptoms and memory distortions within nonclinical populations. However, unlike previous findings, the current study used a novel experimental design, and utilized an original measure of episodic memory distortions (MDQ) instead of relying on wordlist paradigms (Laws & Bhatt, 2005; Roediger & McDermott, 1995; Saunders et al., 2012). In fact, a unique aspect of the present study's design relates to a flexible approach toward measuring memory distortions, which increases its overall ecological validity.

For the two secondary hypotheses, results differed from past studies regarding the relation of memory distortions and neuropsychological functioning. For example, based on PET scan studies of the HERA model, the right prefrontal cortex is associated with episodic retrieval,

while the left prefrontal cortex is related to episodic encoding (Nyberg, Cabeza, & Tulving, 1996). According to Turner et al. (2007), dysfunction to the right prefrontal cortex can cause strategic retrieval deficits and verbal recall intrusions. In contrast, findings from the current study did not indicate a statistically significant relation between left (COWAT) and right (RFFT) frontal lobe functioning with episodic memory distortions. Possibly, the MDQ measured temporal and hippocampal based regions of episodic retrieval (Dolan & Fletcher, 1999), while the neuropsychological tests assessed the decision making process of frontal lobe functioning (Kramer et al., 2005). Also, the recruitment of participants without severe neurocognitive impairments may have elicited normal range scores on frontal lobe functioning.

Despite statistically significant results being found for the primary hypothesis, there were still some inherent limitations to this study. The most apparent limitation relates to the use of participants that met the exclusionary criteria (i.e., psychological illness) being included in subsequent analyses for the full sample (n = 50). However, results from a chi square test of associations proved that participants with a reported psychological illness were equally distributed in both High Distortion and Low Distortion groups. In order to control for this limitation, a follow-up analysis was conducted on the same sample, which excluded participants with a psychological illness (n = 39). Interestingly, the exclusion of these participants resulted in more statistically significant results for the primary hypothesis.

The psychometric validity of the Memory Distortion Questionnaire (MDQ) remains a potential shortcoming. Specifically, the MDQ was created as an original measure of episodic memory distortions, but lacks psychometric data for its validity and reliability. In order to compensate for this limitation, items within the MDQ were constructed based on both face

validity and findings from previous investigations on the influence of misinformation on memory (Loftus et al., 1989; Loftus & Pickrell, 1995).

The direction of future research should be guided toward expanding upon the findings of the current study and improving methodological limitations (i.e., larger sample size, expanded age groups, equal gender ratio, and counterbalanced measures). For example, the primary hypothesis of this study, regarding the relationship between psychosis and memory distortions, was confirmed, but neither secondary hypothesis provided statistically significant results. In order to enhance these findings, future studies should utilize a more comprehensive list of psychosis and neuropsychological measures. Accordingly, this would incorporate a psychometric study to evaluate the validity of the MDQ, along with exploring possible customized alternate forms for various environments. As an outcome, potential development of the MDQ could present the opportunity to distinguish characteristics of memory distortions related to other forms of psychopathology, instead of susceptibility to psychosis.

In conclusion, the implication of results from this study could lead to further investigations about the effect of prodromal psychosis on memory distortions and hemispheric activation during episodic recall. Additionally, understanding the formation of memory distortions in populations at risk for psychopathology can be valuable information for clinical diagnosis, therapeutic treatment, and eyewitness testimony. Consequently, the present study can contribute to scientific literature regarding episodic memory distortions and the exacerbation of psychosis symptoms, while expanding public awareness concerning the faulty nature of human memory.

REFERENCES

Barba, G.D., & Wong, C. (1995). Encoding specificity and intrusion in Alzheimer's disease and amnesia. *Brain and Cognition, 27,* 1-16.

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Beck depression inventory-II (2nd ed.).* San Antonio, TX: The Psychological Corporation.

Benedict, R.H.B., Schretlen, D., Groninger, L., & Brandt, J. (1998). The Hopkins Verbal Learning Test-Revised: Normative data and analysis of interform and test-retest reliability. *The Clinical Neuropsychologist, 12,* 43-55.

Benedict, R.H.B., Schretlen, D., Groninger, L., Dobraski, M., & Shpritz, B. (1996). Revision of the Brief Visuospatial Memory Test: Studies of normal performance, reliability, and validity. *Psychological Assessment, 8,* 145-153.

Borutzky, S., Fujiwara, E., Brand, M., & Markowitsch, H.J. (2008). Confabulations in alcoholic Korsakoff patients. *Neuropsychologia, 46,* 3133-3143.

Brandt, J., & Benedict, R.H.B. (2001). *Hopkins verbal learning test-revised*. Odessa, Fla.: PAR.

Chapman, L.J., Chapman, J.P., & Miller, E.N. (1982). Reliabilities and intercorrelations of eight measures of proneness to psychosis. *Journal of Consulting and Clinical Psychology, 50,* 187-195.

Chapman, L.J., Chapman, J.P., & Raulin, M.L. (1978). Body image aberration in schizophrenia. *Journal of Abnormal Psychology, 87,* 399-407.

Dikmen, S.S., Heaton, R.K., Grant, I., & Temkin, N.R. (1999). Test-retest reliability and practice effects of expanded Halstead-Reitan Neuropsychological Test Battery. *Journal of the International Neuropsychological Society, 5,* 346-356.

Dolan, R.J., & Fletcher, P.F. (1999). Encoding and retrieval in human medial temporal lobes: An empirical investigation using functional magnetic resonance imaging (fMRI). *Hippocampus, 9,* 25-34.

Eichenbaum, H., Sauvage, M., Fortin, N., Komorowski, R., & Lipton, P. (2012). Towards a functional organization of episodic memory in the medial temporal lobe. *Neuroscience and Biobehavioral Reviews, 36,* 1597-1608.

Fals-Stewart, W. (1991). An interrater reliability study of the Trail Making Test (Part A and B). Unpublished manuscript.

Foster, P.S., Williamson, J.B., & Harrison, D.W. (2005). The Ruff Figural Fluency Test: Heightened right frontal lobe delta activity as a function of performance. *Archives of Clinical Neuropsychology, 20,* 427-434.

Goff, L.M., & Roediger, H.L. (1998). Imagination inflation for action events: Repeated imaginings lead to illusory recollections. *Memory & Cognition, 26,* 20-33.

Gilboa, A. (2010). Strategic retrieval, confabulations, and delusions: Theory and data. *Cognitive Neuropsychiatry, 15,* 145-180.

Hannula, D.E., Libby, L.A., Yonelinas, A.P., & Ranganath, C. (2013). Medial temporal lobe contributions to cued retrieval of items and contexts. *Neuropsychologia, 51,* 2322-2332.

Hazlett, E.A., Buchsbaum, M.S., Haznedar, M.M., Newmark, R., Goldstein, K.E., Zelmanova, Y., Glanton, C.F., Torosjan, Y., New, A.S., Lo, J.N., Mitropoulou, V., & Sievar, L.J. (2008). Cortical gray and white matter volume in unmedicated schizotypal and schizophrenia patients. *Schizophrenia Research, 101*, 111-123.

Heilbronner, R.L., Henry, G.K., Buck, P., Adams, R.L., & Fogle, T. (1991). Lateralized brain damage and performance on Trail Making A and B, Digit Span Forward and Backward, and TPT memory and location. *Archives of Clinical Neuropsychology, 6*, 251-258.

Hubbard, L., Tansey, K.E., Rai, D., Jones, P., Ripke, S., Chambert, K.D., Moran, J.L., McCarroll, S.A., Linden, D.E.J., Owen, M.J., O'Donovan, M.C., Walters, J.T.R., & Zammit, S. (2015). Evidence of common genetic overlap between schizophrenia and cognition. *Schizophrenia Bulletin*, sbv*168*.

Keshavan, M.S., Berger, G., Zipursky, R.B., Wood, S.J., & Pantelis, C. (2005). Neurobiology of early psychosis. *British Journal of Psychiatry, 187*, 8-18.

Kessels, R.P.C., Kortrijk, H.E., Wester, A.J. & Nys, G.M.S. (2008). Confabulations behavior and false memories in Korsakoff's syndrome: Role of source memory and executive functioning. *Psychiatry and Clinical Neurosciences, 62*, 220-225.

Kramer, J.H., Rosen, H.J., Du, A.T., Schuff, N., Hollnagel, C., Weiner, M.W., & Miller, B.L., Delis, D.C. (2005). Dissociations in hippocampal and frontal contributions to episodic memory performance. *Neuropsychology, 19*, 799-805.

Laws, K.R., & Bhatt, R. (2005). False memories and delusional ideation in normal healthy subjects. *Personality and Individual Differences, 39*, 775-781.

Loftus, E.F., Donders, K., Hoffman, H.G., & Schooler, J.W. (1989). Creating new memories that are quickly accessed and confidently held. *Memory & Cognition, 17*, 607-616.

Loftus, E.F. (1992). When a lie becomes memory's truth: Memory distortion after exposure to misinformation. *Current Directions in Psychological Science, 1*, 121-123.

Loftus, E.F. (2004). Memories of things unseen. *Current Directions in Psychological Science*, *13*, 145-147.

Loftus, E.F., Levidow, B., & Duensing, S. (1992). Who remembers best? Individual differences in memory for events that occurred in a science museum. *Applied Cognitive Psychology*, *6*, 93-107.

Loftus, E.F., & Pickrell, J.E. (1995). The formation of false memories. *Psychiatric Annals*, *25*, 720-725.

Malla, A., & Payne, J. (2005). First episode psychosis: Psychopathology, quality of life, and functional outcome. *Schizophrenia Bulletin*, *31*, 650-671.

Mangels, J.A., Gershberg, F.B., & Shimamura, A.P., Knight, R.T. (1996). Impaired retrieval from remote memory in patients with frontal lobe damage. *Neuropsychology*, *10*, 32-41.

Mayes, A.R., & Montaldi, D. (1999). The neuroimaging of long-term memory encoding processes. *Memory*, *7*, 613-659.

Moritz, S., Woodward, T.S., Cuttler, C., Whitman, J.C., & Watson, J.M. (2004). False memories in schizophrenia. *Neuropsychology*, *18*, 276-283.

Moritz, S., Woodward, T.S., & Ruff, C.C. (2003). Source monitoring and memory confidence in schizophrenia. *Psychological Medicine, 33*, 131-139.

Nyberg, L., Cabeza, R., & Tulving, E. (1996). PET studies of encoding and retrieval: The HERA model. *Psychonomic Bulletin & Review*, *3*, 135-148.

Obiols, J.E., Serrano, F., Barrantes, N., Garcia-Marimon, M., Gras, S., Bosch, E., Caparros, B., & Carandell, F. (1997). Frontal dysfunction and psychosis proneness in cpt-linked vulnerable adolescents. *Personality and Individual Differences*, *23*, 677-683.

Oertel –Knochel, V., Knochel, C., Rotarska-Jagiela, A., Reinke, B., Prvulovic, D., Haenschel, C., Hampel, H., & Linden, D.E.J. (2013). Association between psychotic symptoms and cortical thickness reduction across the schizophrenia spectrum. *Cerebral Cortex*, *23*, 61-70.

Patihis, L., Frenda, S.J., LePort, A.K.R., Peterson, N., Nichols, R.M., Stark, C.E.L., McGaugh, J.L., & Loftus, E.F. (2013). False memories in highly superior autobiographical memory individuals. *PNAS*, *110*, 20947-20952.

Park, S. (1999). Hemispheric asymmetry of spatial working memory deficit in schizophrenia. *International Journal of Psychophysiology*, *34*, 313-322.

Park, S., & McTigue, K. (1997). Working memory and the syndromes of schizotypal personality. *Schizophrenia Research*, *26*, 213-220.

Peters, E.R., Joseph, S.A., & Garety, P.A. (1999). Measurement of delusional ideation in normal populations: Introducing the PDI (Peters et al. Delusions Inventory). *Schizophrenia Bulletin*, *25*, 553-576.

Peters, E.R., Joseph, S., Day, S., & Garety, P. (2004). Measuring delusional ideation: The 21 item Peters et al. Delusions Inventory (PDI). *Schizophrenia Bulletin*, *30*, 1005-1022.

Raine, A., & Benishay, D. (1995). The SPQ-B: A brief screening instrument for schizotypal personality disorder. *Journal of Personality Disorders*, *9*, 346-355.

Ranganath, C., Johnson, M.K., & D'Esposito, M. (2003). Prefrontal activity associated with working memory and episodic long term memory. *Neuropsychologia*, *41*, 378-389.

Roediger, H.L., & McDermott, K.B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 803-814.

Ross, T.P. (2014). The reliability and convergent and divergent validity of the Ruff Figural Fluency Test in healthy young adults. *Archives of Clinical Neuropsychology*, *29*, 806-817.

Ross, T.P., Foard, E.L., Hiott, F.B., & Vincent, A. (2003). The reliability of production strategy scores for the Ruff Figural Fluency Test. *Archives of Clinical Neuropsychology*, *18*, 879-891.

Rouleau, I., Imbault, H., Laframboise, M., & Bedard, M.A. (2001). Pattern of intrusions in verbal recall: Comparison of Alzheimer's disease, Parkinson's disease, and frontal lobe dementia. *Brain and Cognition*, *46*, 244-249.

Rudebeck, S.R., Bor, D., Ormond, A., O'Reilly, J.X., & Lee, A.C.H. (2012). A potential spatial working memory training task to improve both episodic memory and fluid intelligence. *PLOS ONE*, *7*, 1-9.

Ruff, R.M., Light, R., & Evans, R. (1987). The Ruff Figural Fluency Test: A normative study with adults. *Developmental Neuropsychology*, *3*, 37-51.

Ruff, R. M., Allen, C. C., Farrow, C. E., Niemann, H., & Wylie, T. (1994). Figural fluency: Differential impairment in patients with left versus right frontal lobe lesions. *Archives of Clinical Neuropsychology*, *9*, 41–55.

Saunders, J., Randell, J., & Reed, P. (2012). Recall of false memories in individuals scoring high in schizotypy: Memory distortions are scale specific. *Journal of Behavior Therapy and Experimental Psychiatry*, *43*, 711-715.

Shapiro, A.M., Benedict, R.H.B., Schretlen, D., & Brandt, J. (1999). Construct and concurrent validity of the Hopkins Verbal Learning Test-Revised. *The Clinical Neuropsychologist*, *13*, 348-358.

Siever, L.J., Koenigsberg, H.W., Harvey, P., Mitropulou, V., Laruelle, M., Abi-Dargham, A., Goodman, M., & Buchsbaum, M. (2002). Cognitive and brain function in schizotypal personality disorder. *Schizophrenia Research*, *54*, 157-167.

Simon, A.E., Cattapan-Ludewig, K., Zmilacher, S., Arbach, D., Gruber, K., Dvorsky, D.N., Roth, B., Isler, E., Zimmer, A., & Umbricht, D. (2007). Cognitive functioning in the schizophrenia prodrome. *Schizophrenia Bulletin*, *33*, 761-771.

Smith, S.M., Tindell, D.R., Pierce, B.H., Gilliland, T.R., & Gerkens, D.R. (2001). The use of source memory to identify one's own episodic confusion errors. *Journal of Experimental Psychology: Learning, Memory, and Cognitions*, *27*, 362-374.

Strauss, E., Sherman, E.M.S., & Spreen, O. (2006) *A compendium of neuropsychological tests: Third edition*. New York, NY: Oxford University Press.

Tombaugh, T.N., Kozak, J., & Rees, L. (1999). Normative data stratified by age and education for two measures of verbal fluency: FAS and animal naming. *Archives of Clinical Neuropsychology*, *14*, 167-177.

Tulvig, E., & Donaldson, W. (1972). *Organization of memory: Episodic and semantic memory*. New York, NY: Academic Press.

Tulving, E., Kapur, S., Craik, F.I.M., Moscovitvh, M., & Houle, S. (1994). Hemispheric encoding/retrieval asymmetry in episodic memory: Positron emission tomography findings. *Proceedings of the National Academy of Sciences of the USA*, *91*, 2016-2020.

Turner, M.S., Cipolotti, L., Yousry, T., & Shallice, T. (2007). Qualitativly different memory impairments across frontal lobe subgroups. *Neuropsychologia*, *45*, 1540-1552.

Voglmaier, M.M., Seidman, L.J., Salisbury, D., & McCarley, R.W. (1997). Neuropsychological dysfunction in schizotypal personality disorder: A profile analysis. *Biological Psychiatry*, *41*, 530-540.

Winterer, G., Ziller, M., Dorn, H., Frick, K., Mulert, C., Wuebben, Y., & Herrmann, W.M. (2000). Frontal dysfunction in schizophrenia - A new electrophysiological classifier for research and clinical applications. *European Archives Psychiatry Clinical Neuroscience*, *250*, 207-214.

Woodward, T.S., Buchy, L., Moritz, S., & Liotti, M. (2007). A bias against disconfirmatory evidence is associated with delusion proneness in a nonclinical sample. *Schizophrenia Bulletin*, *33*, 1023-1028.

Woodward, T.S., Moritz, S., Arnold, M.M., Cuttler, C., Whitman, J.C., & Lindsay, D.S. (2006). Increased hindsight bias in schizophrenia. *Neuropsychology*, *20*, 461-467.

Yung, A.R., & McGorry, P.D. (1996). The prodromal phase of first episode psychosis: Past and current conceptualizations. *Schizophrenia Bulletin, 22*, 353-370.

APPENDICES

APPENDIX A

TABLES

Table 1

Participant Demographics

	Frequency	*Percent*
Gender		
Female	35	70.0
Male	15	30.0
Age		
18 yrs-21yrs	29	58.0
22 yrs & Over	21	42.0
Education		
Freshman	10	20.0
Sophomore	12	24.0
Junior	7	14.0
Senior	19	38.0
Graduate	2	4.0
Handedness		
Left	5	10.0
Right	45	90.0
Head Injury		
No	43	86.0
Yes	7	14.0
Neurological Disorder		
No	47	94.0
Yes	3	6.0
Psychological Illness		
No	39	78.0
Yes	11	22.0
Prescription Drugs		
No	38	76.0
Yes	12	24.0
Recreational Drug		
No	50	100.0
Yes	0	0.0

Note. n = 50

Table 2

Initial Analysis: ANOVA Results for Memory and BDI

Measures[c]	*M (SD)*	*F*	*p*
BVMT Total		0.98	.326
LD[a]	29.88 (4.08)		
HD[b]	28.64 (4.73)		
HVLT Total		0.14	.713
LD	26.88 (3.95)		
HD	27.28 (3.68)		
MDQ-Factual		1.77	.190
LD	1.20 (1.00)		
HD	1.64 (1.31)		
BDI-II Total		0.62	.435
LD	9.40 (7.01)		
HD	11.16 (8.70)		
Age (Years)		0.00	.947
LD	22.04 (4.33)		
HD	21.96 (4.12)		

Note. n = 25 per group.
[a]LD = Low Distortion Group. [b]HD = High Distortion Group.

[c]*Note*. Low scores on BVMT, HVLT indicate impaired memory. High scores on MDQ indicate impaired memory. High scores on BDI-II indicate depressive symptoms

Table 3

Primary Analysis: ANOVA Results for Psychosis Measures

Measures[c]	*M (SD)*	*F*	*p*
SPQ Total		4.50	.039*
LD[a]	7.16 (4.39)		
HD[b]	9.76 (4.27)		
SPQ Dis		5.74	.021
LD	1.36 (1.41)		
HD	2.44 (1.75)		
SPQ Cog		3.23	.078
LD	2.80 (1.68)		
HD	3.72 (1.92)		
PDI Total		2.62	.112
LD	66.32 (46.26)		
HD	87.64 (46.79)		
PDI Dis		3.03	.088
LD	16.76 (14.39)		
HD	23.80 (14.18)		
PDI Pre		2.65	.110
LD	19.04 (14.26)		
HD	25.68 (14.59)		
PAS Total		1.39	.244
LD	4.28 (4.44)		
HD	5.96 (5.56)		

Note. $n = 25$ per group.
[a]LD = Low Distortion Group. [b]HD = High Distortion Group.
* $p < .05$
**$p < .0125$ for Bonferoni alpha (SPQ-B Dis, SPQ-BCog, PDI Dis, and PDI Pre)
[c]*Note*. High scores on measures indicate elevated symptoms

Table 4

Primary Analysis: ANOVA Results for Neuropsychological Measures

Measures	*M (SD)*	*F*	*p*
COWAT			
LD[a]	37.64 (11.45)	0.23	.634
HD[b]	36.20 (9.73)		
Animal Naming			
LD	22.52 (5.04)	0.85	.361
HD	21.08 (5.95)		
TMT A			
LD	24.36 (6.43)	0.30	.589
HD	23.32 (7.08)		
TMT B			
LD	57.00 (13.98)	0.70	.408
HD	62.24 (28.06)		
RFFT Total			
LD	88.12 (21.84)	0.00	.981
HD	88.28 (25.42)		

Note. n = 25 per group.
[a]LD = Low Distortion Group. [b]HD = High Distortion Group.

*$p < .01$ for Bonferoni correction

Table 5

Additional Analysis: ANOVA Results for Memory and BDI

Measures[c]	*M (SD)*	*F*	*p*
BVMT Total		2.01	.165
LD[a]	30.61 (3.60)		
HD[b]	28.62 (4.94)		
HVLT Total		0.11	.737
LD	27.44 (3.53)		
HD	27.05 (3.74)		
MDQ-Factual		3.53	.068
LD	1.06 (0.87)		
HD	1.76 (1.37)		
BDI Total		1.08	.305
LD	8.17 (6.39)		
HD	10.81 (9.01)		
Age (Years)		0.25	.621
LD	21.44 (3.65)		
HD	22.10 (4.39)		

Note. n = 18 for (LD); n = 21 for (HD).
[a]LD = Low Distortion Group. [b]HD = High Distortion Group.
[c]*Note*. Low scores on BVMT, HVLT indicate impaired memory. High scores on MDQ indicate impaired memory. High scores on BDI-II indicate depressive symptoms

Table 6

Additional Analysis: ANOVA Results for Psychosis Measures

Measures[c]	*M (SD)*	*F*	*p*
SPQ Total		8.53	.006*
LD[a]	6.00 (3.18)		
HD[b]	9.71 (4.51)		
SPQ Dis		5.62	.023
LD	1.11 (1.23)		
HD	2.28 (1.76)		
SPQ Cog		7.67	.009**
LD	2.33 (1.37)		
HD	3.85 (1.95)		
PDI Total		4.74	.036*
LD	55.06 (37.49)		
HD	86.76 (51.06)		
PDI Dis		5.76	.021
LD	12.72 (10.06)		
HD	22.85 (15.27)		
PDI Pre		4.72	.036
LD	16.17 (11.68)		
HD	26.00 (15.84)		
PAS Total		4.05	.052
LD	2.89 (2.86)		
HD	5.86 (5.65)		

Note. n = 18 for (LD); n = 21 for (HD).
[a]LD = Low Distortion Group. [b]HD = High Distortion Group.
*$p < .05$ for SPQ-B total and PDI total
**$p < .0125$ for Bonferoni alpha (SPQ-B Dis, SPQ-BCog, PDI Dis, and PDI Pre)
[c]*Note*. High scores on measures indicate elevated symptoms

Table 7

Additional Analysis: ANOVA Results for Neuropsychological Measures

Measures	*M (SD)*	*F*	*p*
COWAT		0.20	.658
LD[a]	37.00 (12.88)		
HD[b]	35.38 (9.75)		
Animal Naming		0.84	.366
LD	21.88 (5.67)		
HD	20.24 (5.55)		
TMT A		0.17	.680
LD	24.39 (6.51)		
HD	23.48 (7.11)		
TMT B		0.74	.394
LD	56.72 (12.86)		
HD	63.24 (29.71)		
RFFT Total		0.41	.526
LD	90.06 (21.93)		
HD	85.19 (25.06)		

Note. n = 18 for (LD); n = 21 for (HD).
[a]LD = Low Distortion Group. [b]HD = High Distortion Group.
*$p < .01$ for Bonferoni correction

APPENDIX B

MEMORY DISTORTION QUESTIONNAIRE (MDQ)

These items are to be asked during the second meeting with each participant based on the events they "experienced" during the first meeting.

If a Misleading Question is answered **without** a memory distortion 0 points are given. If an item is answered **with** a memory distortion, 1 point is given. The higher a participant scores on the Misleading Questions reveals a susceptibility to creating distorted memories from misleading information.

Each of the Factual Questions are designed to test non-misleading episodic memory functioning. For items answered **false**, 1 point is given. However, **true** responses receive 0 points. The higher a participant scores on the Factual Questions reveals impaired episodic memory functioning.

☐ 1. Did I tell you that the fire alarm or my phone might go off? (Phone)

☐ 2. Did I ask for your home address or email address for the purpose of the study? (Email)

☐ **3. Were the math questions easy or difficult? (No math questions)**

☐ 4. Did I take the test materials out of my bag or were they already on the table? (Table)

☐ **5. Did I move the questionnaires onto the table or bookcase? (Did not move)**

☐ **6. Was the RA rude or polite when speaking to you? (No RA)**

☐ 7. Were any of the tests printed on color paper or white paper? (White paper)

☐ **8. Were the computer based tests easier or more difficult than the paper tests? (Only paper)**

☐ **9. Did you use a blue or black pen during the first meeting? (Pencil was actually used)**

☐ 10. Did you step over some papers when entering the room or was the path clear? (No papers)

☐ **11. Did I offer you a coke or a juice when you were in the waiting room? (Offered water)**

☐ **12. Did I drop my keys in the waiting room or experimental room? (Did not drop keys)**

☐ **13. Did my cell phone ring during the first or second half of the study? (Does not ring)**

☐ 14. Did you complete the questionnaires first or the test of memory & cognitive functioning? (Questionnaires)

☐ **15. Was the towel I cleaned my spill with blue or green? (Did not clean)**

☐ 16. Did you take all of the tests in the experimental room or the sound attenuated chamber? (Sound Attenuated Chamber)

☐ **17. Was the wet paint sign in the waiting room or experimental room? (No wet paint sign)**

☐ 18. Did you sign a disclosure form or consent form during the study? (Consent form)

☐ 19. Was the door into this room opened or closed when you arrived? (Closed)

☐ **20. Did I open the window in the waiting room or experimental room? (Window not opened)**

☐ 21. Did I take my glasses off or leave them on during the experiment? (Leave on)

☐ 22. Was there a McDonalds bag from my lunch or a water bottle on the table when you arrived? (Water bottle)

☐ **23. Was it a brown or grey rug that I spilled my drink on? (No rug present)**

☐ 24. Was the floor in the sound attenuated chamber carpeted or tiled? (Carpet)

☐ **Total Misleading Score**

☐ Total Factual Score

APPENDIX C

SUBJECT HISTORY AND DEMOGRAPHIC FORM

Subject Number:

Date of Study:

Sex:

Age:

Height:

Weight:

Handedness:

Education:

History of significant head injury (meaning loss of consciousness)? Y/N

If yes, then explain. How long was the loss of consciousness?

History of neurological or psychological/psychiatric illness? Y/N

If yes, then explain.

Currently taking psychotropic medications? Such as medication for depression or anxiety? Y/N

If yes, then explain. What medication (i.e., prescription or recreational)?

APPENDIX D

MTSU INSTITUTIONAL REVIEW BOARD APPROVAL FORM

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Thursday, May 05, 2016

Investigator(s): Jeffery E. Bass (Student PI) and Paul Foster (FA)
Investigator(s') Email(s): *jeb8q@mtmail.mtsu.edu; paul.foster@mtsu.edu*
Department: Psychology

Study Title: ***Episodic memory distortions in individuals prone to psychosis***
Protocol ID: **16-2245**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(7) Research on individual or group characteristics or behavior* A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

IRB Action	APPROVED for one year from the date of this notification	
Date of expiration	5/5/2017	
Participant Size	50 (FIFTY)	
Participant Pool	**MTSU adult students to be recruited through the SONA system**	
Exceptions	Participants are allowed to receive a compensation up to TWO credits	
Restrictions	**Signed informed consent required AND identifiable participant information MUST be destroyed after data collection**	
Comments	NONE	
Amendments	**Date**	**Post-approval Amendments**
		NONE

This protocol can be continued for up to THREE years (5/5/2019) by obtaining a continuation approval prior to 5/5/2017. Refer to the following schedule to plan your annual project reports and be aware that you may not receive a separate reminder to complete your continuing reviews. Failure in obtaining an approval for continuation will automatically result in cancellation of this protocol. Moreover, the completion of this study MUST be notified to the Office of Compliance by filing a final report in order to close-out the protocol.

Continuing Review Schedule:

Reporting Period	Requisition Deadline	IRB Comments
First year report	4/5/2017	INCOMPLETE
Second year report	4/5/2018	INCOMPLETE
Final report	4/5/2019	INCOMPLETE

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions imposed with this approval. Refer to the post-approval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident. Amendments to this protocol must be approved by the IRB. Inclusion of new researchers must also be approved by the Office of Compliance before they begin to work on the project.

All of the research-related records, which include signed consent forms, investigator information and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University
Email: irb_information@mtsu.edu (for questions)
irb_submissions@mtsu.edu (for documents)

Quick Links:
Click here for a detailed list of the post-approval responsibilities.
More information on expedited procedures can be found here.