ANALYZING SCANPATH VARIABLES WITH MMPI-2-RF MEASURES OF THOUGHT DISORDER

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviations
1. Research Domain Criteria (RDoC)
2. Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF)
4. National Institute of Mental Health (NIMH)
5. Behavioral/externalizing dysfunction (BXD)
6. Emotional Internalizing dysfunction (EID)
7. Thought Dysfunction (THD)
8. Ideas of Persecution (RC6)
9. Aberrant Experiences (RC8)
10. Psychoticism-revised (PSYC-r)
11. Diagnostic and Statistical Manual Fifth Edition (DSM-5)

ABSTRACT

ANALYZING SCANPATH VARIABLES WITH MMPI-2-RF MEASURES OF THOUGHT DISORDER

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The National Institute of Mental Health (NIMH) Director Tom Insel has created a new method of researching and conceptualizing mental health dysfunction. Instead of using heterogeneous symptom classifications, Dr. Insel believes a biological approach to understanding dysfunction will lead to more targeted and useful findings. The notion that identifying corroborating biological evidence will benefit the disciplines understanding of mental health disorders is accurate, however, the model of research proposed by Dr. Insel is heavily reliant on biology and ignores important findings in other areas of mental health research. The MMPI-2-RF (Ben-Porath & Tellegen, 2008/2011) is a well-researched and comprehensive self-report measure of psychopathology. In lieu of the research constructs listed by the NIMH, we believe the MMPI-2-RF provides a more valid representation of mental health dysfunction that should be corroborated with biological measures. In this study we evaluated the correlation between measures of thought disorder as described by the MMPI-2-RF and eye-tracking metrics. Participants were 300 undergraduate students from a southeastern, rural university. Participants completed the MMPI-2-RF and their eye-movements were recorded in response to static and full motion video stimuli to investigate the relationship between visual scanning styles or scanpaths and measures of thought disorder. Bivariate correlations and a series of repeated measures analyses of variances

were conducted to parse out the relationship between affectively charged video stimuli, thought dysfunction, and scanpath length. Results indicated there was no significant relationship between elevations on measures of thought dysfunction and scanpath length in response to video stimuli. Implications of these results and future directions are discussed.

CHAPTER ONE: INTRODUCTION

Recently Tom Insel, the Director of the National Institute of Mental Health (NIMH), put forth the Research Domain Criteria Project (RDoC), which steps away from the traditional focus on symptoms for diagnosis of mental health disorders and towards a method of identifying neural circuit dysfunctions that underlie mental health disorders (www.nimh.nih.gov). The RDoC initiative is asking researchers to use a variety of techniques such as imaging, physiological measures, or self-report instruments to identify basic mechanisms that more accurately explain mental health dysfunction than can be done by the current categorical system used in the Diagnostic and Statistical Manual Fifth Edition (DSM-5; American Psychiatric Association, 2013). As explained in a commentary by Insel, Cuthbert, Garvey, Heinssen, Pine, Quinn, Sanislow, and Wang (2010), the need for this new approach to mental health research stems from three sources: current diagnostic categories fail to align with findings of clinical neuroscience and genetics, they are not consistently predictive of treatment response, and they may not adequately explain underlying mechanisms of dysfunction. While medical science has taken advantage of advances in understanding of the basic mechanisms of disease to create precision medicine, psychology and psychiatry have continued to rely on a Kraepelinian diagnostic system. Reflecting on the difference in diagnostic procedure between psychiatric and medical science Dr. Insel said, "…the DSM diagnoses are based on a consensus about clusters of clinical symptoms, not any objective laboratory measure. In the rest of medicine, this would be equivalent to creating diagnostic systems based on the nature of chest pain or the quality of fever" (Insel, 2013).

The problem inherent to relying on symptom consensus in creating a diagnosis can be exemplified when the following diagnoses are examined: schizophrenia, bipolar disorder, and schizoaffective disorder. Schizophrenia is characterized as a heterogeneous disease with symptoms of a psychotic nature, and disturbances in cognitive, behavioral and/or emotional functioning. While the hallmark feature of schizophrenia is the psychotic symptoms, individuals with schizophrenia can present with mood symptoms as well. Bipolar disorder is characterized by oscillating periods of significant depression and manic moods yet individuals can present with mood congruent or incongruent psychotic features. Finally, schizoaffective disorder occupies a middle ground between the two; it is characterized by psychotic symptoms accompanied by depressive or manic mood (APA, 2013). The RDoC project proposes a means of researching constructs that cut across categories so to address the ambiguity between diagnoses as was previously outlined. However, the RDoC project relies heavily on biological measures of dysfunction and ignores important, well-researched psychological constructs. Working within the RDoC framework, this study used the well-researched Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) to evaluate symptom level contributions to eye-movement abnormalities. Abnormalities in visual scanning have been repeatedly observed in individuals with schizophrenia and bipolar disorder, therefore this study sought to better clarify individual symptom contributions to dysfunctions in the visual system.

CHAPTER TWO: LITERATURE REVIEW

<u>History of the Dichotomy between Schizophrenia and Bipolar Disorder</u>

Emil Kraepelin was among the first to dichotomize schizophrenia and bipolar disorder. In 1899 he published the 6th edition of his textbook in which he described dementia praecox (schizophrenia) and manic-depressive insanity (bipolar disorder) as two, identifiably separate disease entities (Angst, 2002). Kraepelin was a student of Wilhelm Wundt and believed mental disorders should be studied via methods of natural science. His aim in differentiating between dementia praecox and manic-depressive insanity was to use neuropathology as validation for the dichotomy he observed (Jablensky, 1999). Kraepelin's contemporaries criticized this view of psychopathology. Hoche (1912) maintained that psychiatric syndromes expressed dispositions while, Bleuler (1922) proposed that there were dimensions of psychosis, all of which existed in every human, making a differential diagnosis between schizophrenia and bipolar disorder unnecessary (Angst, 2002). Conrad (1959) believed clinical and genetic evidence supported the notion that the two disorders were different expressions of general psychosis (Jablensky, 1999). Kraepelin himself, (as cited by Crow, 2008) came to have doubts about the ability of diagnosis by symptoms to distinguish between psychotic and affective disorders, adding that the inability to do so is indicative of a problem in our original construction of the disorders.

Since the inception of Kraepelin's dichotomy the goal has been to amass additional data, specifically neuropathological data, to support the distinction between schizophrenia and bipolar disorder. Over 100 years of research has not generated evidence to substantiate the dichotomy. Instead, research suggests bipolar disorder and schizophrenia have overlapping qualities in the realms of genetics, neuroanatomy, and cross heritability (Craddock & Owen, 2007). However,

even in the face of contradictory evidence, the DSM-5 (APA, 2013) maintains the distinction between schizophrenia and bipolar disorder based on symptom classification alone.

<u>Problems with the DSM-5 Diagnostic Categories</u>

Significant heterogeneity of symptoms for various diagnostic categories questions the utility of distinct categories based on symptoms alone. The goal of any diagnostic system is to create a framework, which aids in the development of targeted treatment modalities, conceptualizations, disease etiology, and prognosis. Kempf, Hussain, and Potash (2005) reviewed current literature relating to psychotic and mood disorders. They concluded that often, treatment for mood and psychotic disorders relies on similar courses of medication (a combination of neuroleptics and mood stabilizers) and there are similar brain abnormalities present in both mood and psychotic disorders. In a longitudinal investigation of the boundaries between psychotic disorders, Kotov, Leong, Moitabai, Erlanger, Fochtmann, Constantino, Carlson, and Bromet (2013) found that there was no meaningful difference between a diagnosis of schizophrenia or schizoaffective disorder. However, their study did reveal non-affective psychosis was predictive of a worse outcome than affective psychosis, indicating there is a significant difference between bipolar disorder with psychosis and other psychotic disorders. Taken together these studies suggest that there is a meaningful difference between schizophrenia and bipolar disorder with psychotic features. However, considering the findings from Kempf et al. (2005) indicating similarities in effective treatments and brain abnormalities, it is unlikely that these are two, mutually exclusive diseases. Categorizing disorders based on symptom presentation alone is an over simplification of the disorder, causing researchers and practitioners to ignore the finite and differing mechanism of dysfunction. Some have likened the ambiguity of

4

overlapping symptoms to the fever of mental illness in that they are nonspecific and uninformative (Tsuang, Stone, & Faraone, 2000).

The Research Domain Criteria project (RDoC) asks researchers to abandon traditional diagnostic categories, to look past the "fever" and towards the cause of the symptoms. Reviewing the case of schizophrenia and bipolar disorder with psychotic features, both present with psychosis, but the prognosis of one is significantly worse than the prognosis of the other.

The significant overlap of symptoms between what are supposed to be discrete categories, is one confound of the current diagnostic system used by the DSM-5 (APA, 2013). However, another confound is the gross ambiguity within a given category. For example, the conceptualization of schizophrenia has fluctuated with each iteration of the DSM. For DSM I and II, emphasis was placed on negative symptoms, DSM III provided the most narrow disease conceptualization with a focus on chronicity and positive symptoms, DSM IV brought a more balanced perspective towards the importance of both negative and positive symptoms, and DSM-5 maintains the perspective of DSM IV, but with less importance placed on bizarre delusions and other positive symptoms (Bruijnzeel & Tandon, 2011). The DSM-5 criteria for schizophrenia are outlined in Table 1. (APA, 2013, Schizophrenia Spectrum and other Psychotic Disorders).

Table 1. DSM-5 Criteria for Schizophrenia

Diagnostic Criteria A.
Two or more or the following:
1. Delusions
2. Hallucinations
3. Disorganized Speech
4. Grossly Disorganized or Catatonic Behavior
5. Negative Symptoms (diminished emotional expression or avolition)
Diagnostic Criteria B.
Level of functioning in one or more major areas is below level prior to onset
Diagnostic Criteria C.
Symptoms persist for at least 6 months
Diagnostic Criteria D.
Schizoaffective disorder and depressive or bipolar disorder with psychotic features have been ruled out
Diagnostic Criteria E.
Disturbance is not attributable to physiological effects of a substance

Given these criteria one individual may present with delusions, hallucinations, and avolition while another individual presents with disorganized speech and diminished emotional expression. Both individuals have no overlapping symptoms yet, because the disease category encompasses such a wide array of symptoms they will be given the same diagnosis, same prognosis and similar course of treatment. While the conceptualization of schizophrenia has fluctuated over the history of the DSM, the heterogeneity of the symptoms has persisted. The current perspective of many researchers and clinicians is that the term "schizophrenia" as defined in the DSM-5 refers to a group of disorders rather than a single disease (Bruijnzeel & Tandon, 2011).

RDoC Framework

Within the RDoC framework, the disease labeled "schizophrenia" would be researched by examining each of its parts individually. The architects of the RDoC project have designed a

matrix from which individual components of schizophrenia can be further studied. The columns of the matrix constitute units of analysis including: genes, molecules, cells, circuits, physiology, behavior, and self-report. The rows of the RDoC matrix are composed of domains of interest, which are further categorized into constructs and sub-constructs. The constructs include: negative valence systems (e.g., fear, threat, anxiety), positive valence systems (e.g., motivation, reward, effort, habit), cognitive systems (e.g., attention, perception, memory), social processes (e.g., affiliation and attachment, communication, understanding of self and others), and arousal and regulatory systems (e.g., arousal, circadian rhythms, sleep-wakefulness) (www.nimh.nih.gov). It should be noted that the current RDoC criteria are intended to be a starting point, the domains and units of analysis will likely change as research evolves (Cuthbert & Insel, 2013).

Working within the RDoC framework, investigators are encouraged to use the units of analysis (columns) to study the domains (rows) outlined in the matrix (Cuthbert and Insel, 2010). For example, while traditionally schizophrenia and bipolar disorder have been investigated separately, the RDoC methodology would require the researcher to identify a construct (e.g., perception) for investigation using one or more of the seven units of analysis. Therefore, instead of starting with a diagnosis and studying the abnormal perceptions experienced by individuals with that diagnosis, the RDoC authors ask researchers to identify a construct of interest first, and then identify individuals who have impairment in this construct, regardless of their disease classification. As has been demonstrated, categorizing schizophrenia and bipolar disorder into two separate disorders ignores the many similarities shared between these categories and is therefore an incomplete understanding of the pathology. By exploring the contributing units of

dysfunction that cut across traditional disease categories, the RDoC authors expect to be able to develop precise conceptualizations of disease etiology.

The RDoC initiative provides a unique counter perspective to the one espoused by the DSM-5; however, it is not without its flaws. While the DSM-5 proposes a diagnostic system solely reliant on symptoms, the RDoC project relies heavily on biological indices of dysfunction to the extent that well researched psychological measures of personality and psychopathology are ignored (, 2014). Examples of such measurement tools are the Minnesota Multiphasic Personality Inventory (MMPI-2-RF; Ben-Porath & Tellegen, 2008/2011) and/or the Personality Psychopathology Five (Harkness, Finn, McNulty, & Shields, 2012).

Minnesota Multiphasic Personality Inventory

The first iteration of the Minnesota Multiphasic Personality Inventory (MMPI) was published in 1943 by Hathaway and McKinley. Originally conceived to be an efficient diagnostic tool, the MMPI consisted of 10 Clinical scales and three Validity scales (Graham, 2012). Item content was pulled from previously existing scales and research about the psychopathology in existence at the time of the MMPI construction. Individual scales were constructed via a method called "empirical keying" in which item responses between two groups of individuals were compared to determine which items differentiated the groups. For the original MMPI the healthy control group consisted of 724 farmers from rural Minnesota who were visiting relatives in the hospital while the comparison group was composed of 221 psychiatric inpatients (Graham, 2012). Over 40 years after the publication of the original MMPI, the MMPI Restandardization Project culminated in the publication of the MMPI-2 (Butcher, Dahlstrom, Graham, Tellegen, and Kaemmer, 1989). Two main goals of the Restandardization Project were to update test norms and irrelevant item content (Ben-Porath, 2012). The MMPI-2 was standardized using a

pool of approximately 2,600 individuals from across the US. Additionally, while the ten Clinical scales and three Validity scales from the original MMPI were retained, three new Validity scales were added as well as Content scales and Supplementary scales.

While the updated norms and item content were vastly beneficial to the utility of the MMPI, the Clinical scales were still plagued by several issues. Between the Clinical scales there was a high level of intercorrelation such that several scales measured similar constructs (Tellegen, Ben-Porath, McNulty, Arbisi, Graham & Kaemmer, 2003). Second, there was significant item overlap between scales, creating ambiguous scale scores (Ben-Porath, 2012). By removing a common factor referred to as Demoralization (Tellegen et al., 2003)., and proceeding with exploratory factor analyses of the entire MMPI-2 item pool, the Restructured Clinical (RC) scales were developed In a review of the RC scales, Hoezle and Meyer (2008) found that use of the RC scales produced a clearer depiction of psychopathology when compared to the Clinical scales. Following the restructuring of the Clinical scales, the MMPI-2-Restructured Form (MMPI-2-RF) was published. In addition to the Restructured Clinical (RC) scales, the MMPI-2-RF included three broad-band scales, referred to as Higher Order scales: Emotional Internalizing Dysfunction (EID), Behavioral Externalizing Dysfunction (BXD) and Thought Disorder (THD). EID is a measure of difficulties within mood and affect, BXD measures difficulties of under controlled behavior, and THD is a measure of disordered thinking (Ben-Porath 2012). As explained by Ben-Porath (2012), the dimensional model of the Higher Order scales (H-O), "…allows for the identification of dysfunction in more than one of these broad domains and can provide an indication of the relative prominence of problems…"(p. 103). The notion that the three broad domains are not mutually exclusive was supported by a study by Lanyon and Thomas (2013). They found that correlations between the three Higher Order (H-O) scales were

substantial, indicating that these are not three distinct categories. In addition to the H-O scales and RC scales, the MMPI-2-RF also includes 23 Specific Problem (SP) scales, two Interest scales and the Personality and Psychopathology-5 (PSY-5) scales developed by Harkness and McNulty (1994). Sellbom, Bagby, Kushner, Quilty, and Ayearst (2012) conceptualize the MMPI-2-RF framework in a hierarchical structure with the H-O scales at the top, most broad level, followed by the RC scales, at a mid-level, and the SP scales at the lowest, most narrow level of the hierarchy. The aim of the paper by Sellbom et. al, (2012) was to examine the construct validity of the MMPI-2-RF and specifically its ability to distinguish between patients with major depression, bipolar disorder and schizophrenia. With the hierarchical structure of the MMPI-2-RF framework in mind, the results of this paper indicated that H-O scales were able to distinguish between diagnostic groups, the RC scales gave additional utility in making distinctions, and the SP scales gave further diagnostic clarity.

As explained by Ben-Porath (2012) the personality literature thus far, for both normal and abnormal personality, reached a general consensus on two higher order factors: Internalizing and Externalizing. In examining the factor structure of both normal personality and psychopathology, Blais (2010) identified factors of internalizing and externalizing psychopathology across both domains. In regards to abnormal personality specifically, there is a need to evaluate a third higher order factor pertaining to major psychiatric disorder. The MMPI-2-RF conceptualizes this as Thought Disorder while the Psychological Screening Inventory-2 (Lanyon, 2010) identifies it as Alienation. Lanyon and Thomas (2013) evaluated the utility of these constructs and found that both the concepts of Alienation and Thought Disorder were useful and relatively interchangeable ideas. As noted previously, the development of the MMPI-2-RF Thought Disorder Scale was part of the general Higher Order Scale development which rendered three broad band scales:

Thought Disorder (THD), Emotional Internalizing (EID) and Behavioral Externalizing (BXD). Development of these three Higher Order scales was accomplished through factor analysis of RC scales. Individual items were incorporated into a Higher Order scale if they were distinctive to one Higher Order construct but not the other two. The resulting THD scale is comprised of 26 items from both the RC6 (Ideas of Persecution) and RC8 (Aberrant Experiences) scales.

As its scale name suggests, all RC6 items are self-referential. If answered in the keyed direction, RC6 describes the respondent as: targeted, controlled, or victimized by outside forces (Tellegen et al., 2003). If one receives an elevated score on RC6 he/she may feel mistreated and have difficulty trusting others. Extremely elevated scorers on this scale are likely to be characterized by paranoid thinking. (Tellegen et al., 2003). In clinical settings, individuals with symptoms of paranoia and mistrust tend to score high on RC6, supporting the description of RC6 correlates offered by Tellegen et al., (2003). Arbisi, Sellbom, and Ben Porath (2008) investigated the correlates of RC scales in psychiatric inpatients. High scorers on RC6 were often described as paranoid and suspicious, admitted for psychosis, and on antipsychotic medication. In a mental health setting Handel and Archer (2009) correlated measures of the Brief Psychiatric Rating Scale (BPRS; Overall & Gorham, 1988) with the MMPI-2-RF RC scales. They found individuals high on RC6 were also likely to be described as being conceptually disorganized, suspicious, have hallucinatory behavior and experience unusual thought content on the BPRS. Finally, in a nonclinical setting Forbey and Ben-Porath (2008) identified elevated scorers on RC6 likely also experience unusual thinking, general mistrust of others, and depression.

RC8 items describe various cognitive, sensory, perceptual and motor disturbances. Individuals who produce elevated scores on RC8 report symptoms such as: visual or olfactory hallucinations, bizarre perceptual experiences, delusional beliefs, and may suggest the presence

of schizotypal characteristics. Exceptionally elevated scores on RC8 indicates the individual is potentially suffering from schizophrenia, delusional disorder or schizoaffective disorder (Tellegen et al., 2003). Supporting these descriptions, Forbey and Ben-Porath (2008) found elevated scores on RC8 to be correlated with thinking and perceptual disturbances in a nonclinical population. In populations of psychiatric inpatients and mental health clients, the correlation between elevated RC8 and impaired perceptual functioning was supported. Psychiatric inpatients with elevated RC8 scores were 1.5 times more likely to experience delusions, were more likely to report auditory and visual hallucinations and were likely to be treated with antipsychotic medication (Arbisi, Sellbom, & Ben-Porath, 2008). Finally, in mental health inpatients, individuals with RC8 elevations were also likely to be found to have conceptual disorganization, hallucinatory behavior, unusual thought content and disorientation measured by the BPRS (Handel & Archer, 2009).

The third scale that contributes to the interpretation of the Thought Disorder Scale comes from the Personality Psychopathology Five scales (PSY-5; Harnkess & McNulty, 1994). Items from the original Minnesota Multiphasic Personality Inventory Second Edition (MMPI-2) were selected using a method called Replicated Rational Selection to construct the PSY-5 scales measuring dimensions of both normal and abnormal personality (Harkness, McNulty, & Ben-Porath, 1995). The resulting five scales were: Aggressiveness, Psychoticism, Constraint, Negative Emotionality/Neuroticism, and Positive Emotionality/Extraversion. Following the restructuring of the MMPI-2 into the MMPI-2-RF, the authors of the PSY-5 were invited to construct a version of the PSY-5 using the 338 item pool of the MMPI-2-RF. The original PSY-5 scales contained a total of 139 items; the PSY-5-RF scales retained 96 of the original items and added 30 items, resulting in a total of 104 items spread across five scales (Harkness, McNulty,

12

Finn, Reynolds, Shields, & Arbisi, 2014). The individual Psy-5-RF scale names are: Aggressiveness (AGGR-r), Psychoticism (PSYC-r), Disconstraint (DISC-r), Negative Emotionality (NEGE-r), and Introversion (INTR-r). Correlations between the PSY-5 and the PSY-5-rf range from .84 for Disconstraint to .94 for Aggressiveness; therefore, in general, the same interpretations can be used for both the PSY-5 and PSY-5-rf scales (Harkness et al., 2014).

Psychoticism (PSYC-r) is the only scale from the PSY-5-rf scales that is used in interpretation of the THD scale. In a review of literature, Harkness, Finn, McNulty, and Shields (2012) found Psychoticism scores to be correlated with personality measures of alienation and mistrustfulness as well as to be predictors of schizotypal and borderline personality symptoms. The restructured Psychoticism scale (PSYC-r) is correlated with both RC6 and RC8 at .68 and .89 respectively (Harkness et al, 2014).

In summary, the MMPI-2-RF is the third iteration of an instrument developed by Hathaway and McKinnely to serve as an omnibus diagnostic tool. The most recent version developed by Tellegen and Ben-Porath (2008;2011) is composed of 338 items that correspond to 51 scales, which can be conceptualized in a hierarchy of Higher-Order scales (H-O), Restructured Clinical scales (RC) and Specific Problem scales (SP). The H-O scales provide the broadest conceptualization of dysfunction correlating to three areas: Thought Disorder, Internalizing Dysfunction or Externalizing Dysfuncion, which are not mutually exclusive (Ben-Porath, 2012). The RC and SP scales serve to add specificity and clarity to the general areas of distress identified by the H-O scales.

The MMPI-2-RF has demonstrated significant diagnostic utility in differentiating between groups of healthy individuals and those with psychopathology related to thought dysfunction (the general focus of the current study). For example, Hunter, Bolinskey, Huudak,

James, Myers and Schuder (2014) investigated the ability of the MMPI-2-RF to differentiate between schizotypic college students and matched controls. In nearly 80% of cases individuals were accurately classified using the MMPI-2-RF. A growing number of empirical studies demonstrate the effectiveness of the MMPI-2-RF as a measure of psychopathology related to thought dysfunction (e.g., Handel & Archer, 2008; Purdon, Purser, & Goddard, 2011; Sellbom et al., 2012)

Eye-Tracking Research in Schizophrenia

The MMPI-2-RF is an undeniably useful tool in identifying psychopathology and more specifically thought dysfunction. However, the impetus for creating a new approach to researching mental health disorders (e.g., the RDoC project) was to better understand the relationship between converging sources of data. For example, the MMPI-2-RF provides reliable measurement of various psychopathology constructs, while measures such as heart rate, brain scans and eye tracking provide biological data of abnormalities that coincide with psychopathology. In the case of schizophrenia, eye-tracking metrics have provided a non-invasive method of quantifying cognitive processes that may be functioning abnormally. Visual scanning and eye-movements provide information about the internal representation of visual stimuli (Norton & Stark, 1971, as summarized by Minassian, Granholm, Verney & Perry, 2005). Eye-tracking metrics can refer to several different movement qualities of the eye. Smooth Pursuit Eye Movements (SPEM) is one such eye-movement variable and it refers to the ability of an individual to continuously track a target moving across her visual field. Holzman, Proctor and Hughes (1973) identified a significant difference in SPEM between individuals with both paranoid and non-paranoid schizophrenia and healthy controls. However, SPEM deficits are not unique to individuals with schizophrenia as they have been found in first-degree relatives of

14

individuals with schizophrenia and in individuals with bipolar disorder (Amador, Sackeim, Mukherjee, Halperin, Neely, Maclin & Schnur, 1991; Iacono, Moreau, Beiser, Fleming & Lin, 1992).

In addition to investigating SPEM, eye metrics such as fixation count and fixation duration have become increasingly useful measures of dysfunction in the schizophrenia literature. Fixation count refers to the number of points of focus made while viewing an image, while fixation duration refers to how long that point of focus is maintained. In relation to healthy controls, individuals with schizophrenia have been shown to make fewer fixations when viewing images (Oh, Chun, Lee & Kim, 2014) and exhibit longer fixation durations (Matsumoto, Takahashi, Murai & Takahashi, 2015). Oh et al. (2014) also found a positive correlation between fixation count and accurate theme identification of still images. Individuals who made fewer fixations accurately identified the theme of images less often indicating that impaired scene viewing has wider implications for how one processes and/or makes use of visual information. More specifically, it has been suggested that in individuals with schizophrenia, abnormal visual movements are reflective of an inflexible information acquisition strategy. Landgraf, Amado, Brucks, Krueger, Krebs and Van der Meer (2011) compared the ability of individuals with schizophrenia and healthy controls on a reasoning task in which participants had to determine the relationship between a pair of visual targets. Their results showed that healthy individuals increased their fixation durations as task difficulty increased whereas individuals with schizophrenia did not adjust their fixation duration as a function of task difficulty. These results support the notion that individuals with schizophrenia are not able to adjust their information acquisition strategy to meet the demands of the task.

Fixation count and fixation duration can be analyzed independently or they can be analyzed together to generate a temporal measure of scanpath. Scanpaths reflect in real time the trajectory of an individual's gaze. Because fixation count and duration can be used to generate a scanpath, these three measures of eye movement are likely reflecting similar cognitive process and information acquisition (Minassian, Granholm, Verney & Perry, 2005). When comparing total length of scanpaths in individuals with schizophrenia and healthy controls, Minassian et al. (2005) found that patients had shorter total scanpaths composed of fewer total fixations but more off-stimulus fixations than healthy controls. These findings indicate there is both a quantitative and qualitative difference in visual scanning behavior between individuals with schizophrenia and healthy controls. They also suggest that individuals with schizophrenia favor a local processing pattern as opposed to a global processing strategy resulting in inflexible information processing. The suggested local vs. global processing strategy adopted by schizophrenia patients was further supported in a study by Landgraf, Amado, Purkhart, Ries, Olie and Van der Meer (2011). They demonstrated an inability of schizophrenia patients to adapt their fixation durations in regards to task difficulty reflecting a more in depth processing of local information and a neglect of global information.

Given the current ambiguity of the DSM-5 conceptualization of schizophrenia, eye-tracking dysfunction provides a concrete depiction of dysfunction inherent to individuals with schizophrenia-like symptoms. They also provide clarity in understanding the relationship of symptoms between schizophrenia and bipolar disorder. Bestelmeyer, Tatler, Phillips, Fraser, Benson and St. Clair (2006) investigated the difference in eye metrics between individuals with schizophrenia, bipolar disorder, and healthy controls. Their results indicated a restricted scanpath consisting of fewer fixations and longer fixation durations for both the schizophrenia and bipolar

patient groups that were significantly different from the healthy control group. These differences were consistent across four different types of images: faces, landscapes, fractals (abstract images), and pink noise (static) reflecting a deficit across image type, not solely in response to social stimuli as previously thought. Schizophrenia and bipolar patient groups did not differ significantly on any eye metrics, however, the bipolar patient group tended to occupy a middle point between the schizophrenia patients and healthy controls in regards to eye-metrics. This reflects the notion that while schizophrenia and bipolar disorder can have overlapping symptoms, schizophrenia represents a more severe dysfunction than bipolar disorder. Further, Benson, Beedie, Shephard, Giegling, Rujescu, and St. Clair (2012), investigated SPEM, scene viewing, and steady fixation in healthy controls and those with schizophrenia. The SPEM task asked individuals to follow a target moving horizontally and in a curvilinear path, the scene viewing task asked participants to freely view a static image, and the steady fixation task asked participants to maintain a steady gaze on a central target for five seconds while ignoring peripheral distractors. Using eye metrics alone, their results were able to distinguish between individuals with schizophrenia and healthy controls with a 98.3% accuracy rate. While the schizophrenia subjects demonstrated impairment on all three visual tasks, they demonstrated the most distinguishable impairment on the free-viewing task. Results of the free-viewing task indicate a restricted viewing pattern compared to healthy controls. While healthy individuals tend to view many points on an image, individuals with schizophrenia tended to gaze at only a select few areas.

Statement of the Problem

The RDoC framework redirects research in psychopathology to focus on specific, measurable, clinically-relevant constructs with sources of data that provide for correlations

17

between psychological (behavioral observations and self-report) data and neurobiological data, including genetic analysis, scan data, electrical, chemical, and physiological data. In reference to schizophrenia, an important area of study has been research concerning the abnormal visual scanning strategies utilized by these individuals. While the RDoC project has taken an important step forward in reframing mental health dysfunction, the domains currently recognized as priority research variables rely on biological indices to the exclusion of well-researched personality and psychopathology variables. The long history of the MMPI suggests that the specific constructs now included in the MMPI-2-RF are reasonably adequate representations of the full domain of psychopathological traits and symptoms. The present study utilized the RDoC matrix in a broad sense, as an implementation of the multitrait-multimethod matrix proposed by Campbell and Fiske (1959) in their study of convergent and discriminant validation. However, instead of the current row variables provided by the RDoC authors, the substantive scales of the MMPI-2-RF will constitute the constructs of interest. Specifically, the scales we will be investigating are RC6 (Ideas of Persecution), RC8 (Aberrant Experiences), PSYC-r (Psychoticism-revised) and THD (Thought Dysfunction).

Additionally, previous literature investigating eye-metrics have used static imagery as their stimulus set. Specifically, this literature has found a restricted scanning style characterized by fewer fixations of longer durations in individuals with schizophrenia. The four scales of interest to this study represent constructs that are often observed in individuals with schizophrenia, thus we can conceptualize individuals with schizophrenia as high scorers on scales RC6, RC8, PSYC-r, and THD. We intend to expand the ecological validity of our study by investigating eye-metrics in response to short videos as well as static images.

Hypotheses

Hypothesis 1:
Previous findings have found a qualitatively restricted visual scanning pattern in individuals with

schizophrenia compared to healthy controls (Bestelmeyer et al., 2006; Benson et al., 2012).

Therefore,

> **1a.** It was hypothesized that MMPI-2-RF scales (RC6, RC8, PSYC-r, and THD) will be
>
> negatively correlated with scanpath metrics.

Hypothesis 2:
The following hypotheses are based on an exploratory evaluation of the data. Individuals with

schizophrenia can be considered to be elevated on measures on the Thought Disorder scales

provided in the MMPI-2-RF, therefore,

> **2a:** It was hypothesized that the relationship between classification via MMPI-2-RF
>
> scales (RC6, RC8, PSYC-r, and THD) and visual scanning pattern will indicate a
>
> restricted scanpath for elevated scores on the scales in response to video stimuli.
>
> Specifically, subjects who are classified in the clinical range will demonstrate a restricted
>
> pattern of visual scanning compared to subjects falling below the clinical range when
>
> viewing the video images regardless of video type (emotionally internalizing v.
>
> emotionally externalizing).
>
> **2b:** When video type is separated (internalizing v. externalizing), it was hypothesized that
>
> the relationship between classification via MMPI-2-RF scales (RC6, RC8, PSYC-r, and
>
> THD) and visual scanning pattern will indicate a restricted scanpath for elevated scores in
>
> response to video stimuli. Subjects who are classified in the clinical range will
>
> demonstrate a restricted pattern of visual scanning for emotionally internalizing and

emotionally externalizing videos individually when compared to subjects falling below

the clinical range.

CHAPTER THREE: METHODOLOGY

<u>Participants</u>

The data are archival in nature. Though they were collected recently for a very similar study, they were not collected specifically for this research. Participants were recruited from a Southeastern university campus through the campus online participant pool. They received course credit in exchange for their participation. Participants consisted of 199 males and 108 females between the ages of 18 and 47. Racial and ethnic configurations were the following: 2.6% Asian, 10.4% African American, 5.5% Hispanic, 78.8% White and 2.6% other. Participants were included if they were 18 years or older and had normal or corrected to normal vision.

<u>Measures</u>

The psychopathology construct of interest (thought disorder) was measured using the Minnesota Multiphasic Personality Inventory-2-Restructured Form. The MMPI-2-RF is a 338-item self-report measure of psychopathology. Four scales contribute specifically to the measurement of thought disorder: RC6 (ideas or persecution), RC8 (aberrant experiences), PSYC-r (psychoticism-revised), and THD (thought dysfunction). The assessment was administered to participants on a laptop in the cognitive neuroscience lab Western Carolina University. Items were presented individually to the participant who answered either "true" or "false" before proceeding to the following question. The scales of interest demonstrate moderate to excellent internal consistency (Cronbach, 1951): THD (.69-.89), RC6 (.64-.85), RC8 (.70-.86), and PSYC-r (.69-.88).

Apparatus and Stimuli

To measure eye-metrics of interest a Tobii™ TX300 Binocular Eye-Tracker (1920 x 1080) was used for presentation of experimental stimuli and eye-metric recordings. Participants were shown either three 30-second emotionally stimulating videos relating to externalizing behavior or three 30-second emotionally stimulating videos relating to internalizing behaviors. All subjects were shown one 30-second neutral video. Videos chosen to evoke notions of externalizing behaviors consisted of: a montage of drug use from the film *Requiem for a Dream,* a compilation of scenes from mixed martial arts fighting, and a scene from the film *Girl with the Dragon Tattoo.* Videos chosen to evoke notions of internalizing behaviors consisted of: a portion of an ASPCA commercial, a viper striking a human foot, and a man on the verge of committing suicide with a hand gun. The neutral video depicted the body of a camera being sanded and prepared for shipment. Each video was followed by three questions pertaining to the content of the video. The questions were employed to ensure participants attended to the visual stimuli. Following the video presentation, participants were shown 32 static images chosen because of their emotionally evocative nature. Images came from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999). Participants were asked to verbalize their initial reaction to each image. After viewing the static images, participants' eye dominance was measured using the hole-in-the-card test. Participants were asked to view the letter 'C' through a board with a hole in the center. Participants were then asked to close the left and right eye individually. When the C was no longer visible, the closed eye was recorded as the dominant eye

Procedure

Participants signed up to participate in this research study through the university online research pool. After reviewing consent material, participants completed the PHQ9 as a measure

of depression prior to participating in this study and were seated in front of individual laptops for completion of the MMPI-2-RF. Participants were then escorted one at a time into the eye-tracker room and seated in front of the Tobii™ TX300 Binocular Eye Tracker. All participants were shown a 30-second affectively neutral video clip as a measure of baseline eye-movement. Following the neutral video presentation, particpants were either shown three 30-second behaviorally externalizing videos or three 30-second behaviorally internalizing videos. Video presentation category was determined based on the day of participation; participants on Tuesdays and Thursdays viewed the behaviorally externalizing video set and participants on Mondays and Wednesdays viewed the behaviorally internalizing video set. Following the presentation of each video, participants were asked to answer three questions relating to the video. Directly following the presentation of the three videos, all participants were shown 32 static images. Upon viewing each image, participants were asked to say the first thought that came to mind. Following the video and static image presentation on the Tobii™ eye tracker, participant's eye dominance was measured using the hole-in-the-card test. Participants then filled out the PHQ9 for a second time as a measure of depression after participation in the study. This concluded the study procedures; participants were thanked for their time and left the lab

Analyses

      Sampling rate data, is generated by the Tobii™ TX300 Binocular Eye-Tracker for each participant, which indicates the accuracy of eye movement recordings. For the purposes of this study, any participant having a sampling rate of less than 30% was excluded from analysis. Fixation count, fixation duration and total scanpath length were be extracted from the eye-tracker data. A ratio of fixation clustering/dispersal was used to quantify the qualitative visual scanning patterns.

To test hypothesis one, bivariate correlations were conducted between scores on RC6, RC8, PSYC-r and THD with scanpath metrics.

To test hypothesis two(a), scores on RC6, RC8, PSYC-r, and THD were divided into two groups: group one consisted of clinically elevated scorers defined by a T-score of greater than 65 and group two consisted of non elevated scorers defined by a T-score less than 64. A series of repeated-measures analyses of variance (ANOVAs) with a series between-subjects variables was conducted on the data using the four video conditions as the interval variable. The between-subjects variables were the emotionally internalizing versus emotionally externalizing video condition, and the diagnostic categories of the four MMPI-2-RF subscales (clinically elevated vs. non clinically elevated). The dependent variable was the scanpath information (scanpath length). For all statistically significant results, eta squared was calculated as the appropriate measure of effect size (Cohen, 1966). For the repeated video condition, Dunnett's test (Dunnett, 1955) was calculated as a *post hoc* measure to parse out pairwise differences between the neutral-video condition and the other three video conditions.

To test hypothesis two(b), the same MMPI-2-RF classification system was used to divide the subjects into groups. In this instance, the emotionally internalizing videos and emotionally externalizing videos were looked at individually to determine the existence of differences across the classification groups in the scanpath information. A series of repeated-measures analyses of variance (ANOVAs) with a series between-subjects variables were conducted on the data using the four video conditions as the interval variable. The dependent variable was again be the scanpath. Eta squared for all statistically significant results and Dunnett's test was calculated as necessary for the interval variable.

CHAPTER FOUR: RESULTS

Prior to analysis, 15 subjects were removed due to missing data resulting in a total of 276

participants (externalizing N = 132; internalizing N = 144).

To address hypothesis 1, results from bivariate correlations between scanpath length in

response to internalizing, externalizing, and boring videos and MMPI-2-RF thought dysfunction

scales (THD, RC6, RC8, PSYCr) are presented in table 2. Within each video category

(internalizing and externalizing) three construct congruent videos were shown. Scanpath length

across the three videos was averaged to generate an average scanpath length for both

externalizing and internalizing videos. No significant correlations were observed between

MMPI-2-RF scales of interest and scanpath metrics.

Table 2. MMPI Correlations

MMPI-2-RF Scales	Externalizing Average Scanpath	Internalizing Average Scanpath	Boring Video Scanpath
THD	-.037	-.051	-.102
RC6	-.051	-.078	-.041
RC8	-.054	.018	-.111
PSYCr	-.054	-.002	-.064

Table Note: MMPI-2-RF = Minnesota Multiphasic Personality Inventory-2-Restructured Form;
THD = Thought Dysfunction; RC6 = Ideas of Persecution; RC8 = Aberrant Experiences;
PSYCr = Psychoticism-Revised

To investigate hypothesis 2a, four repeated-measures analyses of variance (ANOVAs)

with one between-groups variable were conducted to evaluate the effect of clinically elevated

and non-elevated scorers on MMPI-2-RF scales of interest on scanpath length in response to full

motion video. In these analyses, the between-groups variables were the four MMPI-2-RF scales. Subjects in both the internalizing and externalizing conditions were included for analysis. In all four cases, Mauchly's (1940) test of sphericity was violated, indicating that elements in the variance-covariance matrix were unequal. This violation required the Greenhouse-Geisser (1959) adjustment for interpretation of the ANOVAs. Box's (1953) test of equality of covariance matrices was also violated for all four tests, meaning that in each analysis the distribution of scores for clinically elevated and non-elevated subjects were significantly different. In the ANOVAs, significant differences were observed across the four video conditions in all four analyses. However, no differences in scanpath length were observed between clinically elevated and non-elevated scorers in response to the video stimuli. Additionally, there were no significant interactions between the video conditions and the elevation groups. See table 3 for details.

Table 3. ANOVA of Internalizing and Externalizing Conditions

MMPI-2-RF Scales	F_{scan}	F_{group}	$F_{interaction}$	η^2_{scan}
THD	37.693*	2.029	.484	.121
RC6	53.636*	.494	.640	.164
RC8	54.367*	.006	.400	.166
PSYCr	43.109*	.052	.531	.136

Table Note: *$p<.001$
THD = Thought Dysfunction; RC6 = Ideas of Persecution; RC8 = Aberrant Experiences;
PSYCr = Psychoticism-Revised

To investigate hypothesis 2b, eight repeated-measures ANOVAs were conducted evaluating scanpath length in clinically elevated and non-elevated scorers on the four MMPI-2-RF scales of interest. For these ANOVAs, subjects in the internalizing condition were analyzed separately from the externalizing condition. The first four ANOVAs were conducted on the

internalizing videos. For all four of these analyses, Mauchly's (1940) test of sphericity was

violated. This violation required the Greenhouse-Geisser (1959) adjustment for interpretation of

the ANOVAs. Additionally, Box's (1953) test of equality of covariance matrices was also

violated for all four tests. In the ANOVAs, significant differences were observed across the four

video conditions in all four analyses. However, no differences in scanpath length were observed

between clinically elevated and non-elevated scorers in response to the internalizing video set.

Additionally, no significant interactions were observed between video condition and elevation

group. See table 4 for details.

Table 4. ANOVA of Internalizing Condition

MMPI-2-RF Scales	F_{scan}	F_{group}	$F_{interaction}$	η^2_{scan}
THD	34.121*	.234	.771	.197
RC6	44.879*	.556	.908	.240
RC8	45.415*	.719	1.256	.242
PSYCr	36.280*	.227	.742	.204

Table Note: *$p<.001$

THD = Thought Dysfunction; RC6 = Ideas of Persecution; RC8 = Aberrant Experiences;
PSYCr = Psychoticism-Revised

When externalizing videos were evaluated the same pattern arose. Again, Mauchly's

(1940) test of sphericity was violated for all four of these ANOVAs, meaning that elements in

the variance-covariance matrix are unequal. This violation also required the Greenhouse-Geisser

(1959) adjustment for interpretation of the ANOVAs. As before, Box's (1953) test of equality of

covariance matrices was also violated for all four tests, meaning that in each analysis the

distribution of scores for clinically elevated and non-elevated subjects were significantly

different. As with the internalizing videos, significant differences were observed across the four

video conditions in all four analyses. However, no differences in scanpath length were observed

between clinically elevated and non-elevated scorers in response to the internalizing video set.

Additionally, no significant interactions between the video conditions and the elevation groups

were observed. See table 5 for details.

Table 5. ANOVA of Externalizing Condition

MMPI-2-RF Scales	F_{scan}	F_{group}	$F_{interaction}$	η^2_{scan}
THD	23.770*	1.684	1.214	.155
RC6	30.908*	.153	.723	.192
RC8	32.537*	.095	.556	.200
PSYCr	26.401*	.231	.549	.169

Table Note: *$p<.001$

THD = Thought Dysfunction; RC6 = Ideas of Persecution; RC8 = Aberrant Experiences;
PSYCr = Psychoticism-Revised

CHAPTER FIVE: DISCUSSION

To continue to elevate our conceptualization of disorders, utilizing diverse sources of data as is instructed by the RDoC initiative allows research to progress unhindered by arbitrary diagnostic delineations. Prior research comparing only individuals with schizophrenia and healthy controls has demonstrated key differences in eye-movement, which may prove to be diagnostically relevant. This study evaluated the unique contributions of symptoms often present in schizophrenia to eye movement abnormalities. Results of this research may aid in further parsing out the influence of schizophrenic symptoms on the visual system.

Hypothesis 1 predicted that scales of the MMPI-2-RF designed to measure thought dysfunction (THD, RC6, RC8, PSYCr) would negatively correlate with scanpath metrics. This hypothesis was not supported. While the relationship between MMPI-2-RF scales and scanpath length was present in the predicted negative direction, none of these correlations reached significance. These results are incongruent with previous research that has found restricted scanpaths in schizophrenic patients (Delerue, Laprevote, Verfaillie & Boucart, 2010; Loughland, Williams & Gordon, 2002). Given that individuals with schizophrenia are often elevated on the thought dysfunction scales of the MMPI-2-RF it was expected that non-schizophrenic, elevated scorers on these scales would demonstrate a similar restricted scanpath.

Hypothesis 2a predicted that when subjects in both video conditions (internalizing and externalizing) were evaluated together, clinically elevated scorers would demonstrate a restricted scanpath in comparison to non-elevated scorers. This hypothesis was not supported. There was a significant difference in scanpath length across videos; however, there was no significant difference in scanpath length between clinically elevated and non-elevated scorers on any of the

four MMPI-2-RF scales of interest. A similar pattern of results arose in response to hypothesis 2b. Hypothesis 2b predicted that when the internalizing video set and externalizing video set were examined independently, clinically elevated scorers would demonstrate a reduced scanpath regardless of the emotional quality of the video stimuli. This hypothesis was not supported. When evaluating only the internalizing video set, there was a significant difference in scanpath length across videos; however, there was no significant difference in scanpath length between clinically elevated and non-elevated scorers. When evaluating only the externalizing video set, there was again a significant difference in scanpath length across videos; however, there was no significant difference in scanpath length between clinically elevated and non-elevated scorers. As previously stated, the lack of difference in scanpath length between clinically elevated and non-elevated scorers is surprising given that findings with schizophrenic patients have been so robust as to suggest restricted scanpaths may be a biomarker for schizophrenia (St. Clair & Benson, 2011).

When looking at the means plots, it appears that the boring video condition may be exaggerating the results and inflating the significant difference in scanpath length between the four videos. The boring video was chosen to act as a neutral, not affectively charged stimulus. The significant reduction in scanpath length when viewing the boring video is likely a reflection of its non-engaging content. A difference in scanpath length as a function of engagement level of the stimulus is expected for non-elevated scorers. However, previous research has found a qualitatively restricted scanpath in schizophrenic patients regardless of the content of the stimulus (Bestelmeyer et al., 2006); therefore, it was expected that the content of the videos would not influence the scanpath length of clinically elevated scorers. Given that most prior research evaluating eye movement abnormalities in schizophrenic patients has relied on static

images, it may be that affectively charged, full motion videos engage individuals in a manner that static images do not, which is reflected in the normalization of the scanpaths of clinically elevated scorers.

Additionally, when evaluating the means plots of the externalizing video condition, scanpath length in response to video two, a montage of drug use from the movie *Requiem of a Dream,* was similar to scanpath lengths observed in response to the boring video. Both scanpath lengths were significantly less than scanpath lengths observed in response to the remaining two externalizing videos. This suggests that video two of the externalizing video set was not evoking the desired emotional response and should be replaced with a more content valid video should this study be replicated.

Overall, clinically elevated scorers on MMPI-2-RF scales of thought dysfunction did not demonstrate a restricted scanpath in response to either video set in comparison to non-elevated scorers. Given that the thought dysfunction domain of the MMPI-2-RF measures constructs that are often present in schizophrenic individuals, it was predicted that elevated scorers on these measures would demonstrate a similar restriction of eye movement. However, schizophrenia is an amalgamation of many symptoms, beyond those assessed by the MMPI-2-RF thought dysfunction scales. It may be that the abnormal scanpath observed in schizophrenia is the result of neural mechanisms untapped by the MMPI-2-RF.

A separate analysis of this data set for a previous study found a pattern of fixation count and duration similar to that observed in schizophrenic patients. Fixations and saccades contribute to the length of a scanpath, therefore it was expected that the scanpath length should be restricted in a pattern similar to the previously observed reduction in fixations. It may be that even though fixations contribute to scanpath length, the two metrics are differentially affected by the

symptoms measured by the MMPI-2-RF thought dysfunction scales. Differential effects on eye movement mechanisms is not unprecedented. Smooth pursuit eye movement (SPEM), is also impaired in many people with schizophrenia but reflects independent oculomotor and neurocognitive deficits from impaired scanpaths (Beedie, Benson, Giegling, Rujescu & St. Clair, 2012).

Results of this study suggest that clinical elevations on scales measuring thought dysfunction (THD), bizarre perceptual experiences (RC6), aberrant experiences (RC8), and psychoticism (PSYCr) have no bearing on scanpath length. This notion contradicts an abundance of prior literature suggesting that individuals with schizophrenia, who often exhibit symptoms of thought dysfunction as outlined by the MMPI-2-RF, demonstrate a reduced scanpath in response to visual stimuli. Abnormal eye-movements suggest that individuals with schizophrenia are inefficiently processing visual information or are ignoring salient information in the stimulus (Fisher, Graupner, Velichkovsky & Pannasch, 2013; Massaro, Savazzi, Di Dio, Freedberg, Gallese & Gilli, 2012). Inability to efficiently or appropriately process visual stimuli has far reaching negative implications and further clarity as to the mechanism of dysfunction is needed.

Consistent with the goals of the RDoC project, this study evaluated the impact of individual thought dysfunction constructs on eye movement. While findings indicate that elevations on all four of the domain relevant MMPI-2-RF scales are not influential in terms of scanpath length, this null finding has implications for the overall understanding of the intersection of schizophrenia and eye movement abnormalities. It may be that in individuals with schizophrenia, eye movement abnormalities are attributable to processes unrelated to thought dysfunction. Future research should further parse out the contributing symptoms to restricted

visual scanpaths as well as other eye movement abnormalities often observed in the schizophrenic population.

Limitations

       There were several limitations in regards to this research. The participants were not members of a clinical population. They came from a college community, were young, predominantly Caucasian, and well educated. Therefore, comparisons made between results of this study and previous research using a clinically diagnosed, schizophrenic population should be made with caution. Future research would benefit from evaluating this design in a clinically relevant sample. In regards to design of this study, the stimulus videos used were evocative of externalizing and internalizing behaviors; however, a video set evocative of thought dysfunction was not identified. Stimuli specifically relevant to individuals with thought dysfunction would strengthen the study design. Additionally, the videos used in this research are widely available to and viewed by the general public; therefore, participants prior exposure to the stimuli was not controlled for. It is possible that having seen this material prior to this research artificially influenced participants' level of attention to and engagement with the stimuli. Finally, luminance was not controlled for across videos, which also potentially influenced participants' level of engagement with the stimuli in ways that are unknown.

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