

EYE-TRACKER CORRELATES OF MMPI-2-RF NEGATIVE EMOTIONALITY SCALES

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By

Elissa Maria Catherine Cannon

Director: Dr. David M. McCord, Psychology Department

Committee Members: Dr. Alvin Malesky Psychology

Dr. Bruce B. Henderson, Psychology

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TABLE OF CONTENTS

List of Tables	iii
Abstract	iv
Chapter 1: Introduction	1
Chapter 2: Review of Literature	3
Research Domain Criteria (RDoC)	3
Minnesota Multiphasic Personality Inventory (MMPI)	7
Externalizing Disorders Scales	10
Thought Disorders Scales	10
Emotional-Internalizing Scales	11
Eye-tracker Technology and Research	14
Eye-tracker Measures	15
Eye-Tracker and Emotion	16
Statement of the Problem	18
Hypotheses	18
Research Questions	19
Chapter 3: Methods	20
Participants	20
Measures	20
Minnesota Multiphasic Personality Inventory -2 –Restructured Form	20
Eye-Tracker and Metrics	20
Video Stimuli	21
Procedure	21
Data Analyses	22
Chapter 4: Results	24
Chapter 5: Discussion	29
References	32

LIST OF TABLES

Table

1. RDoC Matrix.....	5
2. Hierarchical relationships among internalizing dysfunction scales.....	12
3. Correlations between the 15 MMPI-2-RF internalizing scales and eye tracker metrics using Viper video, time block 2.....	24
4. Correlations between the 15 MMPI-2-RF internalizing scales and eye tracker metrics using ASPCA video, time block 10.....	26
5. Correlations between the 15 MMPI-2-RF internalizing scales and eye tracker metrics using Suicide video, time block 4.....	28

ABSTRACT

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Elissa Maria Catherine Cannon, M.A.

Western Carolina University (April 2015)

Director: Dr. David McCord

The current study is designed to examine correlations between narrow band scales of MMPI and physical indicators accessible to the eye tracker. Prior studies have shown that eye trackers can pick up subtle differences in vision patterns which can relate to psychological disorders, and a pilot study found connections between eye tracker metrics and negative emotionality. Results may yield insight into the connection between individual gaze patterns and personality.

Participants were 146 WCU students. They completed a consent form, short demographics form, PHQ-9, and the 338-item MMPI-RF-2 in a small group setting, and they completed the eye-tracker task individually. They were shown a series of 4 30-second videos with sound and 30 pictures which had previously been rated for emotionality, and the Tobii eye-tracker recorded their gaze patterns, pupillometry, and eye-movement dynamics.

Data analysis showed correlations between the eye tracker variables of pupil size, fixation size, and fixation length with the negative internalizing RF scales of the MMPI-2-RF. This indicates that people with higher levels of internalizing problems may engage in more avoidant activity when presented with negative stimuli.

CHAPTER 1: INTRODUCTION

The National Institute of Mental Health (NIMH) Strategic Plan calls for the development of new ways of classifying mental disorders based upon broad domains of functioning and research-supported dimensional constructs within those domains; informed by genetics, neuroscience, and behavioral science (see the Research Domain Criteria Project, RDoC; <http://www.nimh.nih.gov/research-funding/rdoc.shtml>). This abandonment of traditional broad, heterogeneous syndromes as diagnostic categories, in favor of narrower, unidimensional, focused constructs is paralleled in many ways by the relatively recent restructuring of the Minnesota Multiphasic Personality Inventory. This restructuring resulted in the MMPI-2 Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008/2011), which replaced the classic Basic Scales (e.g., Hysteria, Psychasthenia, etc.) with a hierarchical set of more focused and psychometrically improved measures of specific dimensional constructs.

The current study was designed to examine correlations between narrow-band scales of the MMPI-2-RF and physical indicators accessible to the eye-tracker. Prior studies (Bedell & Stevenson, 2013; Green, Waldron, Simpson, & Coltheart, 2007) have shown that eye-trackers can pick up subtle differences in vision patterns which can relate to psychological disorders. Within the RDoC framework, eye-tracker data provide information regarding neurophysiological processes, whereas MMPI-2-RF data fall under the self-report column. Results may yield insight into the connection between individual gaze patterns, as indicators of underlying neurophysiological processes, and personality pathology.

Prior research (Cannon, Dillard, & McCord, 2014) found consist associations between the MMPI-2-RF measures of negative, internalizing constructs (e.g., anxiety, hopelessness, fears)

and eye-movement dynamics measured by the eye-tracker. This study used static visual imagery and found a pattern of negative correlations between the negative emotionality scale scores and measures of “fixation size,” the area spanned by micro-movements of the eye when focused on a specific location. One hypothesis was that individuals with higher levels of negative emotionality experienced less “attentional engagement” as indicated by visual exploratory behavior. The current research is designed to extend these findings by using more ecologically valid stimulus presentations. Specifically, this project employs full-motion video scenes with sound, as opposed to static pictures, as a means of more fully engaging the participant.

CHAPTER 2: REVIEW OF THE LITERATURE

The following sections will provide a review of the relevant literature. The review will cover current diagnostic models, the controversy surrounding the RDoC, the structure of the RDoC, the MMPI, and the MMPI's revisions, both the Internalizing and Externalizing scales of the MMPI, eye-tracker research, and eye-tracker metrics.

Research Domain Criteria Project (RDoC)

Historically, the major diagnostic systems for mental and psychological disorders have been the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association [APA], 2000/ 2013) and the International Classification of Diseases -10 (ICD-10; World Health Organization [WHO] 2010). The DSM is the standard classification of mental disorders used by mental health professionals in the United States and contains a listing of diagnostic criteria for every psychiatric disorder recognized by the U.S. healthcare system (American Psychiatric Association, 2013). The DSM-5 is a diagnostic system which lists disorders under categories based on their presenting symptomology. The ICD is the only other major diagnostic classification system. The ICD is an internationally recognized means to classify disease and other types of health problems; chapter five of the ICD holds the section on "Mental and Behavioral Disorders," The ICD approach to mental disorders is a categorical model, much like the DSM-5 (World Health Organization, 2010). The DSM and the ICD are both categorical in nature, which is a structure that has been strongly criticized by the Director of the National Institute of Mental Health (NIMH Director Thomas Insel.).

The RDoC system was announced in 2010 and it stirred up substantial discussion in the psychological community. Tom Insel, the Director of NIMH, opened the dialog for the RDoC by

questioning the validity of the DSM and the ICD, and announcing his intent to form a diagnostic system based on neuroscience and genetics (Insel, 2010). Insel complained about the symptom-only focus of the current diagnostic models, the high prevalence of co-morbidity, and the clinical heterogeneity of each disorder. He did assert that the RDoC was for research purposes and not intended to supplant current diagnostic manuals, but he made his criticisms with the current tools known (Insel, 2010). Insel made several points regarding the lack of specificity in mental health diagnoses due to disorders being classified based on behavioral characteristics and lists of symptomology, and he predicted that the RDoC would ultimately allow for the development of more precise categories (Insel, 2012). In the same blog he stated that by 2013 the NIMH planned to have RDoC-themed projects representing a large portion of their research and that they plan to use the RDoC as the framework to guide funding. Insel instigated a storm of controversy just as the DSM-5 was nearing publication by stating that the NIMH would no longer fund research proposals that used traditional DSM diagnostic categories as key variables of interest. This shift in focus within the NIMH has been brewing several years beginning with Peter Lang 45 years ago, it has slowly been gaining ground and is now in the public eye due to Director Insel (Insel et al., 2010).

The RDoC is a dimensional system which spans from normal to abnormal. It does not take current diagnostic categories into account, as it is attempting to generate classifications from behavioral neuroscience (NIMH, 2011). The RDoC does not start with the illness; it begins with the currently understood brain-behavior relationships and then links those to clinical phenomena. RDoC is intended to use several different sources for its analysis. See Table 1 below for a general layout of the RDoC matrix. The RDoC's columns (vertical lines of entries in the matrix) of the matrix represent different classes of variables used to study the constructs. At present

seven columns have been specified; these are genes, molecules, cells, neural circuits, physiology, behaviors, and self-reports. (NIMH, 2011). These columns are designed so that the investigator can select any of them to serve as a correlational variable. (See Table 1.)

Table 1: RDoC Matrix

Domains Units of Analysis

	Genes	Molecules	Cells	Circuits	Physiology	Behavior	Self-Reports	Paradigms
Neg Valance systems								
Acute Threat								
Potential Threat								
Sustained Threat								
Loss								
Frust. Non reward								

The RDoCs’s rows correspond to “constructs,” or dimensions of functioning. These are concepts which summarize data about a functional dimension of a behavior, and which are

subject to constant refinement as based on advances in the sciences. Related constructs are grouped together as domains of functioning. There are five domains: Negative Valence Systems (i.e., systems for aversive motivation such as Acute threat (“fear”), Potential Threat (“anxiety”), or loss), Positive Valence Systems such as Approach motivation, Reward learning, and Habits, Cognitive Systems such as Attention, perception, and cognitive control , Systems for Social Processes, Reception of facial communication, attachment formation, and perception and Arousal/Regulatory Systems such as arousal, sleep and wakefulness, and Circadian rhythms. (National Institute of Mental Health, 2011). The groupings reflect the current thinking about aspects of cognition, motivation, behaviors, and so on (National Institute of Mental Health, 2011).

The RDoC constructs are based on current literatures which have provided a neurobehavioral research base for each entry. The inclusion of a construct was also based on whether a brain circuit or area could be specified to implement the dimension of behavior. That is, rather than starting with a pathology construct based on its established clinical relevance, such as hopelessness, or suicidality, the NIMH researchers started with constructs that emerged from neurobiological research projects using technologies such as fMRI and genetic analyses. This selection process enhances the likelihood that research projects will indeed discover significant associations among variables; however, this approach to identifying constructs worthy of study may not result in a set of constructs that is broadly representative of the full range of psychopathology experienced in applied settings. It is partially due to these reasons that in the present study we did not use the rows outlined in the RDoC and chose to use the MMPI categories instead. As will be seen below, the normative groups and the specific scales of the MMPI have been substantially changed over time, but the initial large item set is generally

recognized as quite comprehensive with regard to psychopathological signs and symptoms (Ben-Porath, 2012).

The Minnesota Multiphasic Personality Inventory (MMPI)

Development of the MMPI began in the mid to late 1930s, and by 1940 creators Hathaway and McKinley had begun to create a large number of items from which a variety of scales could be constructed in hopes of evolving more valid personality descriptors (Ben-Porath & Tellegen, 2008/2011). Hathaway and McKinley created these items in answer to the increasing skepticism of the times regarding the reliability and validity of existing self-report measures, and in order to facilitate a more accurate diagnosis of patients. While constructing items McKinley and Hathaway used the descriptive, diagnostic, classification system of the 1930s. They developed a large pool of potential items and used empirical keying to construct the original eight MMPI clinical scales. These eight scales differentiated eight groups of patients who were diagnosed with hypochondriasis, depression, hysteria, psychopathic deviance, paranoia, psychasthenia, schizophrenia, and hypomania, from non-patients. Later, scales to detect homosexual tendencies and social introversion were added to the basic scales (Ben-Porath & Tellegen, 2008/2011). The original scales did not work quite as intended, and researchers began to use scale configural profiles instead of the individual scales. By the 1960s the MMPI was being used to assess normal and abnormal personality characteristics and symptoms of psychopathology. Scales were also being made to interpret the MMPI as based on item content as opposed to external correlates (Ben-Porath & Tellegen, 2008/2011).

Although the MMPI became the most widely used measure of personality and psychopathology, researchers had become aware that it had some flaws (Ben-Porath, 2012). In 1982 the revision of the MMPI was begun and by 1989 the MMPI-2 was published. The most

immediate change to the MMPI-2 was the collection of new norms. While the MMPI's norms had been viable for the time in which it was created, the test was being used in far more diverse settings and, as such, the old norms were no longer as effective. The norms had been collected from people waiting for their relatives in a hospital and consisted of a very small number of individuals, mostly young, white, and married people from rural Midwestern geographic areas. The MMPI-2 also updated some of the test items, and items deemed offensive or not scored on any of the widely used scales were removed (Ben-Porath & Tellegen, 2008/2011). Two response inconsistency scales, VRIN and TRIN, were added to identify protocols with random or faked responding.

Importantly, this major revision of the MMPI left the 10 basic clinical scales ("Basic Scales") essentially intact. This decision was made to enhance familiarity and continuity for the very large community of clinical psychologists who used the MMPI regularly. However, it was known by this time that the Basic Scales were too heterogeneous, with a high overlap among items on scales, and high cross-scale correlations. In an effort to address these major psychometric deficiencies, Tellegen and Ben-Porath (2003) developed the Restructured Clinical Scales ("RC Scales") and made them available as an additional resource for the MMPI-2.

The RC scales corrected for the heterogeneity of the basic scales by creating a measure of "demoralization" as a common nonspecific factor which contributes to the shared variance, and to the heterogeneity of the scales. Demoralization is the shared factor that increases the correlations between scales which would otherwise be expected to be quite independent. Demoralization items were then isolated from each of the RC scales via a two or three factor solution. Seed scales were then created for each of the 12 clinical scale components. Analyses were run to maximize the representativeness and distinctiveness of the 12 scales.

Nine final RC scales were constructed representing demoralization and the major distinctive core of the eight original clinical scales. These RC scales were added to the MMPI-2 to assist in interpreting the clinical scales profile by way of significantly enhanced discriminant validity (Ben-Porath & Tellegen, 2008/2011).

The MMPI-2-RF revision? began with the intent of reviewing all 567 items in the MMPI-2's pool and identifying areas for additional substantive scale construction to create a more comprehensive and exhaustive set of scales. In addition to the RC scale construction, analyses were conducted to create a comprehensive set of substantive scales and a series of validity scales. These are scales designed to assist the interpreter in identifying invalid test results, they also inform the interpreter of possible feigning or denial of problems. The result was 8 validity scales, 9 RC scales, 3 new Higher-Order scales, and 25 Specific Problem scales (Ben-Porath & Tellegen, 2008). A revised set of PSY-5 scales were also constructed by Harkness and McNulty (2007) that provide a temperament- oriented perspective of pathology and link the MMPI-2-RF to the Five Factor Model of personality (ref) . The addition of the validity, substantive, and PSY-5 scales led to the initial 50- scale MMPI-2-RF, and the subsequent addition of a 9th validity scale (RBS) resulted in the current 51-version test.

As noted above, the authors of the RF chose to develop three Higher-Order scales based on factor analysis of the nine RC scales. These reflect the traditional “prototype” configurations found with the traditional Basic Scales. The EID (Emotional/ Internalizing Dysfunction) scale includes anxiety, depression, and other negative affect constructs, and was formerly represented by the “2-7” codetype. The BXD (Behavioral/ Externalizing Dysfunction) scale includes acting-out patterns such as substance use, fighting, rule-breaking, and so forth, formerly represented by the “4-9” codetype. Finally, the THD (Thought Dysfunction) scale includes symptoms of

hallucinations and delusions, formerly represented by the “6-8” codetype. These Higher Order scales were conceptualized as broad measures of psychological dysfunction and delineate broad domains of affect, action, and thought. Though the current study is based on the internalizing negative emotions and, as such, focuses on the internalizing disorders, both the externalizing dysfunction scales and the thought dysfunction scales will be briefly reviewed in the following sections for the sake of completeness.

Externalizing Disorders Scales

The Behavioral-Externalizing Dysfunction (BXD) scale is composed of 23 items and assesses a broad range of behavioral problems; it also provides a gauge of acting out problems. It is associated with two RC scales, RC4 (Antisocial Behavior) and RC9 (Hypomanic Activation), each of which is in turn associated with two Specific Problem (SP) scales. RC4 consists of 22 items which measure antisocial behavior and related family conflict. It is represented by the SP scales JCP (Juvenile Conduct Problems) and SUB (Substance Abuse). JCP is composed of 6 items which are associated with juvenile delinquency and acting out. SUB consists of 7 items associated with an increased risk for substance abuse, including alcohol and drugs, sensation seeking, and impaired functioning due to drugs. RC9 is comprised of 28 items which describe emotions, attitudes, and behaviors associated with hypomanic activation, such as racing thoughts, heightened mood and self-regard. RC9 is further refined in the AGG (Aggression) and ACT (Activation) SP scales. AGG consists of 9 items which describe physically aggressive behavior; elevated AGG indicates a history of interpersonal abusiveness and violence. ACT is comprised of 8 items which describe instances of heightened excitement and energy level, lack of sleep, and uncontrollable mood swings (Ben-Porath & Tellegen, 2008/2011).

Thought Disorders Scales

The THD (Thought Dysfunction) scale is a 26-item scale which measures a broad area of difficulties associated with thought dysfunction. It indicates an estimate of client reported thought disturbances. The THD scale is composed of scores from RC6, RC8, and PSYC-r. RC6 (Ideas of Persecution) is composed of 17 items which assesses the extent of the test takers persecutory beliefs. Elevated scores on RC6 indicate significant persecutory thinking. RC8 (Aberrant Experiences) has 18 items which describe perceptual experiences characterizing disordered thinking and experiences of unusual thoughts. Elevated scores indicate significantly disorganized thinking and symptoms of psychotic disorders. PSYC-r is one of the PSY-5 (Personality Psychopathology Five) scales. PSYC-r (Psychoticism-Revised) consists of 26 items describing experiences associated with thought disturbance. Elevated scores indicate unusual perceptual experiences and thoughts, and with being alienated from others.

Emotional-Internalizing Scales

For the current study the focus is on the 15 internalizing scales of MMPI-2-RF, which include the EID Higher-Order scale (Emotional/Internalizing Dysfunction), 3 of the RC scales (RCd, RC2, and RC7), 2 of the PSY-5 scales (INTR-r and NEGE-r), and 9 of the Specific Problem scales. These scales are organized theoretically in a hierarchical structure (Ben-Porath, 2012) depicted in Table 2.

Table 2. Hierarchical relationships among internalizing dysfunction scales



EID is a 41 item scale which assesses a broad range of internalizing and emotion problems. EID provides an overall gauge of the test taker’s emotional functioning. EID is divided into three RC scales: RCd, RC2, RC7; these form a mid-level conceptual layer. The Three RC scales are further divided into 11 narrower SP scales which form the base level.

There are four internalizing scales which are aspects of the RCd (Demoralization) scales. RCd is a 24-item scale which represents a pervasive and affect-laden dimension of unhappiness and life dissatisfaction. RCd is reflected in the substantive scales Suicidal/ Death ideation (SUI), Helplessness/ Hopelessness (HLP), Self-Doubt (SFD), and Inefficacy (NFC). SUI is made of 5 items which describe recent suicidal ideation or behaviors; scores on SUI strongly indicate suicidal behavior or thoughts. HLP is comprised of 5 items which describe beliefs that the person cannot overcome their problems. High HLP scores are associated with feeling that life is a strain and feeling hopeless, helpless, overwhelmed, and believing they receive a raw deal. SFD consists of 4 items that describe lack of confidence and feeling useless, associated with feelings of

inferiority, insecurity, and self-disparagement. NFC has 9 items depicting the belief that one is incapable of making decisions and dealing with major or minor crises (Ben-Porath & Tellegen, 2008/2011).

RC2 (Low Positive Emotions) is composed of 17 items and assesses depressive symptoms. INTR-r (Introversion/ Low Positive Emotion- Revised) is one of the PSY-5 scales that falls within the RC2 conceptual domain. INTR-r consists of 20 items which describe a lack of positive emotional experiences and avoidance of social situations and interactions. Elevated scores are associated with social introversion, anhedonia, restricted interests, and pessimistic outlook. INTR-r is negatively associated with the Extraversion dimension of the five factor personality model. Elevated INTR-r scores were associated with features of the DSM-IV cluster C disorders which represent anxious and fearful disorders and include Avoidant, Dependent, and Obsessive-Compulsive Personality Disorders.

RC7 (Dysfunctional Negative Emotions) is composed of 17 items and assesses the extent to which the test taker holds beliefs of persecution, reflecting extreme beliefs. RC7 is reflected in the substantive scales of Stress/ Worry (STW), Anxiety (ANX), Anger proneness (ANP), Behavior Restricting Fears (BRF), and Multiple Specific Fears (MSF). STW includes 7 items that describe stress and worry, including preoccupation with disappointment, difficulties with pressure and specific worries. ANX is comprised of 5 items describing experiences of anxiety and anxiety-related problems sleep difficulties, post-traumatic distress, and intrusive ideations. ANP is made of 7 items which describe anger and anger related tendencies. BRF consists of 9 items which describe fears that significantly restrict typical activities both in and out of the home. MSF has 9 items which describe various fears of various animals or acts of nature and related to phobias (Ben-Porath & Tellegen, 2008).

The MMPI-2-RF is the current version of the most frequently used self-report measure of psychopathology, and MMPI data may be placed in both the “Self-Report” and the “Behavior” columns of the RDoC matrix. As stated above, the goal of the RDoC initiative is to link such data to its biological and neurophysiological underpinnings, and in the present study we are using eye-tracker technology for this purpose. The history, development, and current findings of eye-tracker research are reviewed in the following section.

Eye-Tracker Technology and Research

Attempts to record human eye movements began near the end of the 19th century with Professor E.B. Delabarre, who magnified eye movements with plaster, a small mirror, and a beam of light (Delabarre, 1898). Mechanical attachments gave way to photographic techniques. Dodge (1903) recorded the movement of the reflected light shone into the cornea on a moving photographic plate and began to distinguish major sub-classes of eye movement: saccades, smooth pursuit, vergence, vestibular, and optokinetic responses (Bedel & Stevenson, 2013). These early photographic eye-movement recordings were cumbersome, hard to acquire, and they required controlled light and precise head stabilization. Once the records were obtained, they took a great deal of time to analyze. For all of these reasons early eye-tracking was, for the most part, uncommon in clinic settings.

Eye-tracking became more common in the mid-20th century when it became frequently used to detect neurobiological abnormalities. Records of eye movements became easier to obtain, and eye-tracker methods became more complex (Bedel & Stevenson, 2013). Eye-tracking has become important in diagnosing, documenting, and managing many neurological abnormalities, such as peripheral and central vestibular imbalances, and brainstem, cerebellar and cortical lesions. Many of the clinical applications of eye-movement recording are summarized in Leigh

and Zee (2006). Eye-tracking is also being used in the field of psychology to examine how people view the world. Studies in experimental psychology have been using the eye-tracker to identify and analyze gaze patterns (Melnik, McCord, & Vaske, 2014), and to identify idiosyncratic eye movement profiles and determine if they are related to attention (Poynter, Barber, Inman, & Wiggins, 2013). The eye-tracker has also been used to connect a lack of control over eye movements to ADHD (Munoz, Armstrong, Hampton, & Moore, 2003).

Eye-Tracker Measures

Observing the patterns in which eyes move can tell us a great deal about what has captured a person's attention and for how long. Observing where and for how long a person's eyes fixate on a stimulus can tell us what has captured their attention and the strength of that attention. According to Richards (2001) all individuals with normal vision demonstrate similarities in eye-movement behavior that are present from early childhood through adulthood. Pupillometry, the measure of pupil size, has been used for over 50 years in various ways, beginning with measurements of cognitive load and more recently to specify cognitive/affective occurrences during experimental tasks. Pupil size is not only affected by light levels but also is an indicator of thoughts, emotions, arousal, and load on attentional capacity (Laeng, Sirois, & Gredebäck, 2012). The measure of pupil size is the average pupil diameter across fixations for a single stimulus. Eye-tracking uses pupil size as a reliable measure of both positive and negative arousal (Aboyoun & Dabbs, 1998; Bradley, Miccoli, Escrig, & Lang, 2008) Pupil size will be measured for both pupils individually.

Fixation frequency (or count) is the number of fixations that occur during a single stimulus. In A study on types of praise Zentall and Morris (2012) found that children who received generic praise (which decreases motivation) had a higher number of longer fixations

than those who received specific praise (which increases motivation). Fixation count is also higher when participants are looking at more complex stimuli (Wang, Yang, Liu, Cao, & Ma, 2014). In this study fixation count will measure both attention and avoidance.

Fixation duration measures the average duration of fixations for a single stimulus or the length duration of individual fixations. Rinck & Becker (2006) established that ‘spider fearful’ participants exhibited shorter fixation durations when viewing pictures of spiders. Similar results were found in a study by Wieser, Pauli, Weyers, Alpers, & Muhlberge (2009), students with a high fear of negative evaluation had shorter fixations on angry faces and longer fixations on happy faces. Fixation duration can be used as a measure of both attention, avoidance, and fear.

Fixation size measures the spatial extent of all types of fixation eye-movements (tremors, drifts, and micro-saccades). The micro-saccadic movements involved in fixation size indicate attention (Jaing, Won, & Swallow, 2014). Micro-saccadic movements serve to gather more information around the fixation point and then begin to divert to the new locus of attention before a new fixation occurs (Schmidt, Belopolsky, & Theeuwes 2014; Cavanagh, Wiecki, Kochar, & Frank, 2014; Martienez-Conde, Macknik, Troncoso, & Dyar, 2006; Engbert & Kliegl, 2003). Saccadic movements can also be used to examine how quickly people can arrest their visual attention from focusing on something they do not want to look at (Carbone & Schneider, 2010; Van der Stigchel, Mills, & Dodd, 2010).

Eye Tracker and Emotion

There is a great deal of research connecting eye movements to externalizing emotions (Munoz, et al., 2003; Tseng, Cameron, Pari, Reynolds, Munoz, & Itti, 2012) and to thought dysfunction (Nagel, Sprenger, Steinlechner, Binkofski, & Lencer, 2012; Sprenger, Trillenberg,

Nagel, Sweeney, & Lencer, 2013). However there is less research connecting eye movements to internalizing emotions. For example there are several instances of disorders which affect eye movement such as eye avoidance in autism where people are more likely to focus on the mouth and do not pick up emotional cues from the eye region (Annaz, Karmiloff-Smith, Johnson, & Thomas 2009). Recently research has begun to delve more fully into the internalizing side of eye movements. Research has found evidence that currently depressed individuals display greater sustained pupil dilation than never-depressed individuals in the seconds following stimuli on emotional informational processing tasks (Siegle, Granholm, Ingram, & Matt, 2001). Evidence has also linked pupillary constriction to anxiety. In one study, individuals scoring high on worry and rumination trait tendencies had smaller pupil dilation following personally relevant negative emotional stimuli than those scoring low on these traits (Oathes, Siegle, & Ray, 2011). Green, Waldron, Simpson, and Coltheart (2007) found that schizophrenia patients demonstrated significantly fewer saccadic eye movements when viewing context free images and significantly longer eye-fixations when viewing context-embedded images. Low levels of pupil dilation during tasks have also been linked with remission in cognitive therapy patients with depression; (Siegle, et al. 2011). Kashihara, Okanoya , and Kawai (2013) found that emotional images inducing negative feelings altered the appearance rate of microsaccades as well as the pupil size and found that micro-saccades rebound and rate of response are significantly inhibited by attention to negative emotions. Looking patterns have also been found to vary depending on whether the topic of an image evokes a positive or negative response, unpleasant images evoked more visual avoidance behavior (Budimir & Palmovic 2011). Much of the research regarding internalizing disorders has to do with the cognitive loading process and how it is affected by positive and negative stimuli, and rumination. Preliminary data from a pilot study (Cannon,

Dillard, & McCord, 2014) suggests that there is a strong correlation between pupil size, fixation duration, fixation count, and fixation size and internalizing negative emotionality.

Statement of the Problem

Diagnostic manuals are used on a daily basis by practitioners of psychology and psychiatry, the predominant ones being the DSM-5 and the ICD-10. Both of these manuals use categorical models, and while both manuals have been updated several times, they do not incorporate the breakthroughs of other scientific fields. When diagnosing mental disorders there is an absence of specific biomarkers, co-morbidity is frequent, and there is a great deal of clinical heterogeneity within each disorder. Because of this, diagnosis can be confounding in both the research and practice of psychology.

A push for a more dimensionally based diagnostic system is taking place in the field of psychology, and new research in the fields of neuroscience and genetics are finding links between mental disorders, genes, and neural networks (Haber & Rauch, 2010).

The purpose of this study is to contribute data towards a dimensional approach to diagnosis by providing links between the narrow band scales of the MMPI-2-RF and physical indicators accessible to the eye-tracker. This study can provide information regarding both neurophysiological processes and self-report measures. It may yield insight into the connections between individual gaze patterns, as indicators of underlying neurophysiological processes, and personality pathology.

Hypotheses

Testable Hypothesis# 1: Individuals higher in negative emotionality will feel less arousal and correlations between all 15 MMPI-2-RF internalizing scales and pupil size, will be significant and negative.

Testable Hypothesis# 2: Individuals higher in negative emotionality will pay less attention to stimuli and engage in less exploratory behavior thus a significant negative correlation is predicted between fixation count and all 15 MMPI-2-RF internalizing scales.

Testable Hypothesis #3: Individuals higher in negative emotionality will pay less attention to the full image and engage in less visual exploration and will instead have longer looking times than those lower in negative emotionality. Thus, we expect a positive correlation between the 15 internalizing scales and fixation duration.

Testable Hypothesis #4: Individuals higher in negative emotionality will pay less attention and engage in less visual exploratory behavior than those lower in negative emotionality. Thus, we expect a negative correlation between the 15 internalizing scales and fixation size.

Research Questions

Research Question #1: Will there be significant associations between the broader negative emotionality scales (EID, RCd, RC2, RC7, and MLS) and the fixation size ratio metric of the eye-tracker?

Research Question #2: Will individuals higher in negative emotionality show less arousal than normative participants? Arousal will be assessed by the pupil size of the participants.

CHAPTER 3: METHOD

Participants

Participants were 146 university students, of mixed gender and ethnicity. The average age of participants was 18. All participants were undergraduate students of Western Carolina University, a midsize university located in the southern region of the United States. The participants received course credit for participating in the research.

Measures

The following measures were administered:

Minnesota Multiphasic Personality Inventory -2 –Restructured Form

The Minnesota Multiphasic Personality Inventory -2 –Restructured Form (MMPI-2-RF) is one of the most widely used and researched measures of abnormal personality and psychopathology. It is a 338 item instrument that is measured using a true/false system. It has 51 scales which indicate different types of personality and psychopathology, scores above 65 on individual scales mark elevated levels of the psychopathology. The MMPI-2-RF's normative sample was drawn from the MMPI-2 normative sample and consists of 2, 276 men and women between the ages of 18 and 80 from several regions and communities in the United States.

Eye-Tracker and Metrics

The Tobii TX 300 model eye-tracker is a non-invasive method of tracking eye movements. The Tobii is built into a 23-inch diagonal monitor and is controlled via an adjacent monitor. The Tobii permits full head movement which allows a more natural situation. The tracker has a 300Hz gaze capture frequency and has been found to be both precise and accurate in recording movements.

Four metrics are associated with the eye tracker as well as a ratio measure of each. The four measures are left pupil size, right pupil size, fixation count, fixation duration, and fixation size. Pupil size is the average pupil diameter in mm across all fixations for single stimuli or the average diameter for all stimuli of a given type. This was measured independently for the left and the right pupil's fixation frequency is the number of fixations occurring for a single stimuli or the average number of fixations across stimuli of a given type. Fixation duration is the average duration of fixations (ms) for a single stimulus or average duration across all stimuli of a given type. Fixation size measures the spatial extent of all types of fixation eye-movements (tremors, drifts, and micro-saccades). It is the average distance of gaze points in a fixation cluster from the mean of all cluster gaze-points.

Video Stimuli

In order to evoke the negative internalizing emotions associated with the various eye-tracker metrics we selected videos which represented some of the 15 MMPI-2-RF internalizing scales. All of the videos would produce arousal and attention for a typical individual. We expected that all three videos would tap into the overarching higher order EID scale and the three RC scales (RCd, RC2, and RC7), we wanted to focus our videos on the specific problems scales. We utilized a video of a striking snake to evoke anxiety and fear represented by ANX, BRF, MSF, STW, NEGE-r, and STW. We utilized an ASPCA Sarah McLaughlin advert video to illicit feelings of helplessness and anger represented by the scales HLP, NFC, and ANP. The final video was of a young man committing suicide, it was chosen to illicit suicide ideation, feelings of stress, and helplessness represented by the scales SUI, HLP, NFC, STW, and INTR-r.

Procedure

The study occurred in the campus eye-tracker lab. Students were tested in small groups of six or less. They were first provided with and asked to read and sign a consent form before data collection began. They were also asked to fill out the PHQ-9 as a pretest measure of their psychological wellbeing, this was in compliance with IRB requirements. No identifying data was attached to the MMPI, thereby allowing the participants to retain some anonymity.

After the participants read and agreed to the consent form and other form they were given brief instructions on how to fill out the MMPI-2-RF. Each participant was given a laptop with the electronic version of the MMPI-2-RF. The MMPI will also asked for some demographic information (age, sex, ethnicity, relationship status, current medication, and years of schooling). While the group at large is filling out the MMPI, participants were be asked to go to an adjacent room where they viewed a series of preselected video clips on the Tobii eye-tracker. The clips were selected by lab members to relate to MMPI scales which were easier to visualize, suicide, anxiety, and helplessness/ hopelessness. Several clips were chosen from YouTube and the most relevant were selected by the lab. The individual was then returned to the main room to complete the MMPI. Participants were be asked to answer all questions on the MMPI; however they could discontinue participation at any time without consequence. Following the completion of the MMPI participants were given a posttest version of the PHQ-9 and were debriefed by a master's student. The full process took about one hour which varied based on the students reading ability and compliance. To ensure that participants experienced no ill effects from the study they were contacted by phone the next day for an additional posttest measure.

Data Analyses

The three testable hypotheses were evaluated with bivariate correlation coefficients. This was used to measure the strength of the correlation between the individual eye tracker metrics and the 15 MMPI-2- RF internalizing dysfunction scales.

CHAPTER 4: RESULTS

Due to the amount of data collected we isolated the climax or most intense scenes from each video, it was critical to show the full clips for the sake of context however some portions of the videos were not as stimulating and would not have drawn attention nor evoked arousal in participants. The first video showed a snake striking multiple times at a leg in slow motion. The data for the viper video (Figure 3), shows correlations with pupil size, fixation size, and fixation duration. EID, HLP, SFD, STW, RCd, and RC7 all show positive correlations with pupil size indicating that during this section of the video participants pupil size increased. This increase can be indicative of a strong arousal reaction and greater processing load (Laeng, 2012). NFC, STW, and MSF showed a negative correlation with fixation count, this indicates that these participants displayed less exploratory behavior when watching the video. HLP, BRF, MSF, and NEGE-r showed a negative correlation with fixation duration. This means that they did not linger on any one point of the stimulus but instead moved their gaze more frequently than normal. STW and MSF demonstrated a negative correlation with both fixation count and fixation duration.

Table 3: Correlations between the 15 MMPI-2-RF internalizing scales and eye tracker metrics using Viper video, time block 2.

	Left Pupil	Right Pupil	Fixation Count	Fixation Duration	Fixation Size
EID	.251**	.253**	-.177	-.160	.094

HLP	.216*	.134	.047	-.208*	-.025
SUI	.109	.134	-.013	-.109	-.060
NFC	.073	.071	-.207*	-.089	.067
SFD	.261**	.230*	-.081	-.126	.072
AXY	.136	.154	-.061	-.065	-.074
STW	.204*	.154	-.198*	-.174	-.029
ANP	.105	.106	-.048	-.098	-.034
BRF	.010	.043	-.182	-.220*	-.019
MSF	-.045	-.008	-.259**	-.209*	.137
RCd	.240*	.238*	-.097	-.150	.076
RC2	.075	.101	-.125	-.011	.079
RC7	.204*	.203*	-.141	-.179	.014
INTR-r	.046	.105	-.011	.118	-.021
NEGE-r	.161	.125	-.213*	-.198*	-.013
BXD	.111	.120	.183	.024	-.030
THD	.002	-.045	.131	-.209*	.021

Note: Significant correlations are red, bolded, and indicated with asterisks for $p < .01$ (**) or $p < .05$ (*). THD and EID are included for broad discriminant comparison.

The second video was of the, now infamous, Sarah McLaughlin ASPCA video. This has lots of very sad looking animals with a sad song playing. This video was selected for evoking the feelings of helplessness, inefficacy, and in some cases anger. The data for this video (Figure 4) shows that the right pupil size was negatively correlated with NFC, STW, BRF, and NEGE-r, indicating less arousal. Fixation count was negatively correlated with ANP and RC2. Fixation duration was positively correlated with ANP and BXD. Fixation size was positively correlated with EID, SFD, AXY, STW, RCd, RC7, and NEGE. People with higher scores in ANP had less fixations but each one was longer. STW and NEGE-r showed a negative correlation with right pupil size and a larger fixation size.

Table 4: Correlations between the 15 MMPI-2-RF internalizing scales and eye tracker metrics using ASPCA video, time block 10.

	Left Pupil	Right Pupil	Fixation Count	Fixation Duration	Fixation Size
EID	-.069	-.136	.024	.010	.186*
HLP	-.040	-.079	-.053	-.070	.003
SUI	-.082	-.131	.018	-.059	.024
NFC	-.159	-.194*	.083	-.121	.034
SFD	-.015	-.076	-.033	.103	.253**

AXY	-.046	-.086	-.030	-.006	.182*
STW	-.078	-.168*	.053	.023	.177*
ANP	.004	-.041	-.269**	.187*	.161
BRF	-.134	-.181*	.011	-.079	.149
MSF	-.035	-.103	.008	-.005	.104
RCd	-.064	-.145	.040	.020	.230**
RC2	-.112	-.138	.180*	-.119	.043
RC7	-.058	-.100	-.034	.006	.185*
INTR-r	-.045	-.093	.017	-.061	-.058
NEGE-r	-.088	-.172*	-.009	.048	.197*
BXD	-.076	-.061	-.131	.171*	.063
THD	-.025	-.025	-.030	.026	.035

The third video, the ‘Suicide’ video, displayed a young man contemplating a gun before raising it to his head, the image cut off before a shot was fired. The data (Figure.5) from this section shows shorter fixations but a larger fixation size. NFC, ANP, BRF, RC7, and NEGE-r displayed a negative correlation with fixation duration. EID, SFD, BRF, RCd, and RC7 show larger fixation sizes. BRF and RC7 show both shorter duration and larger size, BRF falls under RC7 in the hierarchical model.

Table 5: Correlations between the 15 MMPI-2-RF internalizing scales and eye tracker metrics using Suicide video, time block 4.

	Left Pupil	Right Pupil	Fixation Count	Fixation Duration	Fixation Size
EID	.101	.121	-.029	-.138	.201*
HLP	.135	.121	-.062	-.160	-.002
SUI	.032	.075	.027	-.026	.045
NFC	.077	.058	-.017	-.183*	.127
SFD	-.006	.011	-.024	-.133	.217*
AXY	.050	.038	-.039	-.160	.088
STW	.176*	.117	-.032	-.092	.096
ANP	-.010	-.018	-.127	-.193*	.098
BRF	.122	.162*	-.075	-.203*	.186*
MSF	.087	.111	-.123	-.155	.100
RCd	.106	.107	-.019	-.149	.187*
RC2	.108	.115	.057	-.159	.145
RC7	.096	.091	-.088	-.249**	.186*

INTR-r	.057	.061	.064	.036	-.010
NEGE-r	.060	.038	-.064	-.166*	.129
BXD	.030	.044	-.036	-.005	-.046
THD	.030	.028	-.043	-.082	-.010

Some of the correlations showed continuity across videos. EID and SFD were positively correlated with fixation size in both for both the ASPCA and suicide videos. STW was correlated with pupil size for both the viper and suicide videos. ANP was correlated with fixation duration for both the ASPCA and suicide videos; the correlation was positive for the ASPCA video and negative for the suicide video. BRF correlated with pupil size for the ASPCA and suicide videos; the correlation was negative for the ASPCA video and positive for the suicide video. RCd and RC7 were positively correlated with fixation size for both the ASPCA and suicide videos. Finally NEGE-r was negatively correlated with fixation duration for both the viper and suicide videos.

CHAPTER 5: DISCUSSION

Regarding our hypotheses, we did not consistently find what we expected. Hypothesis one dictated that correlations between all 15 MMPI-2-RF internalizing scales and pupil size would be significant and negative. Most of the significant correlations with pupil size were positive, the ASPCA video was the only one which demonstrated negative correlations; however none of them were significant. This is likely due to a greater level of arousal among individuals higher in negative emotionality than originally anticipated. This relates to the low levels of exploratory behavior expected in hypotheses two and three.

Hypothesis two predicted a significant negative correlation between fixation count and all 15 MMPI-2-RF internalizing scales. Participants displayed a negative correlation indicating that they were looking at fewer parts of the videos. Hypothesis three predicted that individuals higher in negative emotionality would engage in less visual exploratory behavior and longer looking times than those lower in negative emotionality. Participants did engage in less visual exploratory behavior as indicated by hypothesis two; however, participants displayed a negative correlation between the 15 internalizing scales and fixation duration. We expected a positive correlation which would be indicative of an individual focus on one area; however based on the data participants appeared to be engaging in fixations of a shorter duration. In keeping with the hypotheses on low levels of visual exploration, hypotheses four predicted a negative correlation between the 15 internalizing scales and fixation size. The correlation was positive indicating an increased fixation size and greater interest.

Based on the current data it appears that when confronted with a negative or frightening stimuli individuals with higher levels of negative emotionality demonstrate pupil dilation indicating arousal. They then attempt to avoid confronting the negative stimuli as indicated by the lower fixation count and duration. A lower fixation count when paired with shorter fixation durations would indicate that the person is trying to look at the video as little as possible, thus avoiding the negative stimuli.

Some potential problems with this study are the population which was composed solely of college students. Also due to the population there were few instances of individuals with high levels of negative internalized disorders. Another potential problem lies with the videos, while we tested them to the best of our ability in the lab; the selection process was not based on strong evidence. Different videos which have been rated for their impact on a larger sample would have been ideal.

Future directions for this research would involve different populations, particularly with individuals who have diagnosed internalizing disorders. The research would also benefit from participants viewing real life situations with which they can relate on a day to day level. This could be accomplished by recording more realistic scenarios, or by the use of mobile eye tracker devices. This is a new area of focus and there is a great deal of research that needs to be done; however it shows some promise.

REFERENCES

- Aboyoun, D. C., & Dabbs, J. M. (1998). The Hess Pupil dilation findings: Sex or novelty? *Social Behavior & Personality: An International Journal*, 26(4), 415-420.
- American Psychiatric Association. (2000). *Diagnostic and statistical manual for mental disorders* (4th ed., text rev.). Washington, DC: American Psychiatric Association.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.) . Arlington, VA: American Psychiatric Publishing.
- Annaz, D., Karmiloff-Smith, A., Johnson, M.H., & Thomas, M.S.C. (2009) Development of holistic face recognition in children with autism, Down syndrome and Williams syndrome. *Journal of Child Experimental Psychology*, 102, 456–486.
- Bedel, H. E., & Stevenson, S. B. (2013). Eye movement testing in clinical examination. *Vision Research*, 90, 32-37.
- Ben-Porath, Y. S. (2012). *Interpreting the MMPI-2-RF*. Minneapolis, MN: University of Minnesota Press.
- Ben-Porath, Y. S., & Tellegen, A. (2008/2011). *MMPI-2-RF (Minnesota Multiphasic Personality Inventory—2 Restructured Form) manual for administration, scoring, and interpretation*. Minneapolis, MN: University of Minnesota Press.
- Bradley, M. M., Miccoli, L., Escrig, M. A., & Lang, P. L. (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology*, 45, 602-607.
- Cannon, E. M., Dillard, A., & McCord, D. M. (2014, March). *Correlations between eye-tracker variables and MMPI-2-RF Negative Affect Scales*. Paper/poster presented at the 60th Annual Meeting of the Southeastern Psychological Association, Nashville, TN.

- Carbone, E., & Schneider, W. X. (2010). The control of stimulus-driven saccades is subject not to central, but to visual attention limitations. *Attention, Perception & Psychophysics*, 72(8), 2168-2175. doi:10.3758/APP.72.8.2168
- Cavanagh, J. F., Wiecki, T. V., Kochar, A., & Frank, M. J. (2014). Eye tracking and pupillometry are indicators of dissociable latent decision processes. *Journal Of Experimental Psychology: General*, 143(4), 1476-1488. doi:10.1037/a0035813
- Delabarre, E. B. (1898). A method of recording eye movements. *American Journal of Psychology*, 9, 572–574.
- Dodge, R. (1903). Five types of eye movements in the horizontal meridian plane of the field of regard. *American Journal of Physiology*, 8, 307–309.
- Budimir, S., & Palmovic, M. (2011). Gaze differences in processing pictures with emotional content. *Collegium Antropologicum*, 35(1), 17-23.
- Engbert, R., & Kliegl, R. (2003). Microsaccades uncover the orientation of covert attention. *Vision Research*, 43, 1035–1045.
- Green, M. J., Waldron, J. H., Simpson, I., & Coltheart, M. (2007). Visual processing of social context during mental state perception in schizophrenia. *Journal of Psychiatry & Neuroscience*, 33, 34-42.
- Haber, S. N., & Rauch, S. L. (2010). Neurocircuitry: A window into the networks underlying neuropsychiatric disease. *Neuropsychopharmacology*, 35(1), 1-3.
- Harkness, A. R., & McNulty, J. L. (2007). An overview of personality: The MMPI-2 Personality Psychopathology Five Scales (PSY-5). In J. N. Butcher (Ed.), *Pathways to MMPI-2 use:*

- A practitioners guide to test usage in diverse settings*. Washington, DC: American Psychological Association
- Insel, T., Cuthbert, B., Garvey, M., Heinssen, R., Pine, D., Quinn, K., Sanslow, C., & Wang, P. (2010). Research domain criteria (RDoC): Toward a new classification framework for research on mental disorders. *American Journal of Psychiatry*, *167*(7), 748-751.
- Insel, T. (2010, February 1). Director's blog: Re-thinking classification of mental disorders. Retrieved from <http://www.nimh.nih.gov/about/director/2010/re-thinking-classification-of-mental-disorders.shtml>
- Insel, T. (2011, November 15). Director's blog: Improving diagnosis through precision medicine. Retrieved from <http://www.nimh.nih.gov/about/director/2011/improving-diagnosis-through-precision-medicine.shtml>
- Insel, T. (2012, March 6). Director's blog: Research domain criteria--RDoC. Retrieved from <http://www.nimh.nih.gov/about/director/2012/research-domain-criteria-rdoc.shtml>
- Jaing, Y. V., Won, B., & Swallow, K. M. (2014). First saccadic eye movement reveals persistent attentional guidance by implicit learning. *Journal of Experimental Psychology: Human Perception and Performance*, *40*(3), 1161-1173.
- Kashihara, K., Okanova, K., & Kawai, N. (2014). Emotional attention modulates microsaccadic rate and direction. *Psychological Research*, *78*(2), 166-179.
- Laeng, B., Sirois, S., & Gredebäck, G. (2012). Pupillometry: A window to the preconscious. *Psychological Science*, *7*(1), 18-27.
- Leigh, R. J., & Zee, D. S. (2006). *The neurology of eye movements* (4th ed.). Oxford: Oxford University Press.

- Martinez-Conde, S., Macknik, S. L., Troncoso, X. G., & Dyar, T. A., (2006). Microsaccades counteract visual fading during fixation. *Neuron*, *49*, 297-305.
- Melnyk, J. W., McCord, D. M., & Vaske, J. (2014). Gaze pattern variations among men when assessing female attractiveness. *Evolutionary Psychology*, *12*(1): 167-177.
- Munoz, D. P., Armstrong, I. T., Hampton, K. A., & Moore, K.D. (2003). Altered control of visual fixation and saccadic eye movements in attention-deficit hyperactivity disorder. *Journal of Neurophysiology*, *90*, 503-514.
- Nagel, M., Sprenger, A., Steinlechner, S., Binkofski, F., & Lencer, R. (2012). Altered velocity processing in schizophrenia during pursuit eye tracking. *Plos ONE*, *7*(6), doi:10.1371/journal.pone.0038494
- National Institute of Mental Health. *The National Institute of Mental Health Research Domain Criteria (RDoC)*, MD: National Institute of Mental Health. 2011. <http://www.nimh.nih.gov/research-priorities/rdoc/nimh-research-domain-criteria-rdoc.shtml>
- Oathes, D.J., Siegle, G.J., & Ray, W.J. (2011). Chronic worry and the temporal dynamics of emotional processing. *Emotion*. *11*, 101–14.
- Poynter, W., Barber M., Inman, J., & Wiggins, C. (2013). Individuals exhibit idiosyncratic eye-movement behavior profiles across tasks. *Vision Research*, *89*, 32-38.
- Richards, J. E. (2001). Cortical indexes of saccadic planning in infants. *Infancy*, *2*, 123–133.
- Schmidt, L. J., Belopolsky, A. V., & Theeuwes, J. (2014). Potential Threat Attracts Attention and Interferes With Voluntary Saccades. *Emotion*, doi:10.1037/emo0000041

- Siegle, G. J., Granholm, E., Ingram, R. E., & Matt, G. E. (2001). Pupillary response and reaction time measures of sustained processing of negative information in depression. *Biological Psychiatry*, *49*, 624–636.
- Siegle, G. J., Steinhauer, S. R., Friedman, E. S., Thompson, W. S., & Thase, M. E. (2011). Remission prognosis for cognitive therapy for recurrent depression using the pupil: utility and neural correlates. *Biological Psychiatry*, *69*, 726–33.
- Sprenger, A., Trillenber, P., Nagel, M., Sweeney, J. A., & Lencer, R. (2013). Enhanced top-down control during pursuit eye tracking in schizophrenia. *European Archives of Psychiatry And Clinical Neuroscience*, *263*(3), 223-231. doi:10.1007/s00406-012-0332-9
- Tseng, P., Cameron, I. G.M., Pari, G., Reynolds, J. N., Munoz, G. P. & Itti, L. (2012). High-throughput classification of clinical populations from natural viewing eye movements. *Journal of Neurology*, *260*(1), 275-284.
- Van der Stigchel, S., Mills, M., & Dodd, M. D. (2010). Shift and deviate: Saccades reveal that shifts of covert attention evoked by trained spatial stimuli are obligatory. *Attention, Perception & Psychophysics*, *72*(5), 1244-1250. doi:10.3758/APP.72.5.1244
- Wang, Q., Yang, S., Liu, M., Cao, Z., & Ma, Q. (2014). An eye tracking study of website complexity from cognitive load perspective. *Decision Support Systems*, 1-10.
- Zentall, S. R., & Morris, B. J. (2012). A critical eye: Praise directed toward traits increases children's eye fixations on errors and decreases motivation. *Psychonomic Bulletin & Review*, *19*, 1073-1077.
- World Health Organization. (2010). *ICD-10: International statistical classification of diseases and related health problems* (4th ed.). Geneva.