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Attentional Deployment, Cognitive Control, and Reappraisal in Schizophrenia

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ABSTRACT

Recent studies posit that deficits in emotion regulation may lead to increased negative emotional experience in schizophrenia. While individuals with schizophrenia evidence a number of abnormalities in emotion regulation, it is unclear whether these deficits are discrete or related; furthermore, the mechanisms underlying these deficits are not clear. Cognitive control has been posited as an important mechanism supporting emotion regulation. The current study examined the relationship between attentional deployment and both lexical and self-reported indices of reappraisal, as well as the mediating role of cognitive control on this relationship in a sample of 22 individuals with psychotic disorders. A novel eye-tracking paradigm was used in which participants were asked to view thematically related positive and negative images while verbal reappraisals were elicited in order to examine the relationship between attentional deployment and reappraisal. Cognitive control was measured by the AX-CPT. Results indicated that cognitive control alone was not a significant mediator in the relationship between attentional deployment and reappraisal. However, post hoc analyses indicated cognitive control was a significant mediator in a group of individuals who rated positive stimuli as more intense than negative stimuli, suggesting that individual differences in emotional reactivity may moderate this relationship between lower- and higher-order emotion regulation strategies.

CHAPTER 1. INTRODUCTION

Individuals with psychotic disorders evidence increased negative emotional experience. Evidence in support of increased negative emotional experience is fairly consistent across studies (Blanchard, Mueser, & Bellack, 1998; Cohen & Minor, 2010). However, the mechanism behind this is less clear. One contemporary theory posits that increased negative emotion may be due to deficits in emotion regulation (Kring & Werner, 2004; Strauss et al., 2013), or "the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (Gross, 1998b). Individuals with schizophrenia evidence abnormalities in higher-order (i.e., reappraisal; Horan, Hajcak, Wynn, & Green, 2013; Strauss et al., 2013) and lower-order (i.e., attentional deployment; Strauss et al., 2014) emotion regulation strategies. However, little is known about how these higher- and lower-order strategies interact in individuals with psychosis. Individuals with schizophrenia also evidence deficits in cognitive control. Cognitive control has been implicated as an important mechanism supporting several cognitive processes like attention and working memory, as well as processes important for emotion regulation. Given that emotion regulation and cognitive control have been posited to utilize common mechanisms (Ochsner & Gross, 2005), emotion regulation strategies may be differentially affected by abnormalities in cognitive control in individuals with schizophrenia. Therefore, the current study seeks to examine the relative contribution of attentional deployment in reappraisal; to clarify whether deficits in reappraisal are related to, or discrete from, the deficits in attentional deployment in individuals with schizophrenia; and to examine cognitive control as a mediator between attentional deployment and reappraisal strategies. A pertinent literature review is provided below, followed by an overview of the current study.

1.1 A Transtheoretical Model of Psychosis

Research Domain Criteria, a transtheoretical model of psychosis, has been proposed. This model posits that symptom clusters are relatively ineffective at characterizing differences and similarities of individuals within a given diagnostic category. Instead, theorists have proposed that psychiatric phenomena are dimensional rather than discrete, and seek to understand these phenomena across units of measurement from genetic to self-report. Recognizing domains of clinical phenomenon allows researchers to draw conclusions about individuals who experience a specific symptom (i.e., negative affect, hallucinations) rather than individuals with a given diagnosis. Because schizophrenia is the most debilitating and prevalent disorder among the psychotic disorders, it has been intensively studied. Below is an introduction to schizophrenia, followed by an introduction to the affective abnormalities that accompanies a diagnosis of schizophrenia.

1.2 Schizophrenia

The most common and perhaps most debilitating disorder among the psychotic disorders is schizophrenia (Harrow, Grossman, Herbener, & Davies, 2000; Perälä et al., 2007). Schizophrenia is responsible for reduced social and occupational functioning. These symptoms contribute to a high disease burden, with a global annual loss of 5.66 million years of healthy life (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Schizophrenia has a lifetime prevalence of 0.4 – 1.0 percent of the population (American Psychiatric Association, 2013; Bhugra, 2005). According to the Diagnostic and Statistical Manual – 5th edition (DSM-5; American Psychiatric Association, 2013), schizophrenia consists of a set of symptoms in two or more domains, including positive symptoms (e.g., delusions and hallucinations), negative symptoms (diminished emotional experience, avolition, blunted facial and vocal affect, reduced speech production, and lack of normal emotional distress), and disorganized speech or behavior, which are present for at least 6 months. Furthermore, functioning in one or more major areas (e.g., work, interpersonal relationships, self-care) is markedly lower than prior to the onset of the disorder. Aside from the classic clinical diagnostic symptoms, individuals with schizophrenia exhibit abnormalities in neurocognition (e.g., memory, attention, processing speed; Fioravanti, Bianchi, & Cinti, 2012), social cognition (Green, Olivier, Crawley, Penn, & Silverstein, 2005; Penn, Sanna, & Roberts, 2008), and some abnormalities in emotional experience (for a review, see Kring & Elis, 2013). Despite the negative impact that schizophrenia has on the healthcare system and individuals diagnosed with the disorder, its etiology is largely unknown.

A number of genetic, environmental, and neurobiological factors are believed to play a role in the development of schizophrenia. Heritability studies suggest that approximately 83 percent of phenotypic variance in schizophrenia is due to genetic factors (Cannon et al., 1998). These findings indicate much larger genetic associations than large-scale Genome Wide Association Studies (GWAS), which suggest that consistent, identifiable Single Nucleotide Polymorphisms (SNPs – variations in individual structural components of genes) explain only approximately 10 percent of the variance in the disorder (Harrison, 2015). This pattern of findings suggests that schizophrenia is likely a polygenic disorder (Gershon, Alliey-Rodriguez, & Liu, 2011). However, environmental and epigenetic (gene expression maintained across the life of the organism not influenced by changes in DNA sequence; Masterpasqua, 2009) factors are also likely responsible for increased risk of schizophrenia, though the relative contribution of these risks is not easily quantifiable due to the range of epigenetic mechanisms that may confer additional risk (Roth, Lubin, Sodhi, & Kleinman, 2005). Apart from the genetic underpinnings of schizophrenia, there are many neurobiological risk factors. Among these abnormalities are structural (e.g., reduced total brain volume and grey matter abnormalities in the prefrontal cortex) and neurochemical (reduced GABAergic and Glutamatergic expression in prefrontal areas), as well as functional (reduced dorsolateral prefrontal cortical functioning) abnormalities (Walker, Kestler, Bollini, & Hochman, 2004). Neuroendocrine (reduced N-acetyl aspartate signaling in select regions of the brain), neuropathological (reduced glial proliferation), and neurophysiological (abnormal eye movement) anomalies have also been noted (Keshavan, Tandon, Boutros, & Nasrallah, 2008).

The positive, negative, and disorganized symptoms of schizophrenia manifest at different times and have varying time courses (Tandon, Nasrallah, & Keshavan, 2009). Positive symptoms are those symptoms that represent an increase or addition of healthy processes, or "additions or elaborations of normal experience" (Beck, Rector, Stolar, & Grant, 2009). These include delusions (i.e., strongly held, sometimes bizarre, thoughts that persist in the presence of evidence to the contrary; Garety & Hemsley, 1994) and hallucinations (i.e., perception of auditory, visual, olfactory, or tactile input in the absence of external stimuli). Disorganized symptoms are fragmentations of logic and goal-directed nature of thought (Andreasen, 1979; Tandon et al., 2009). Disorganized symptoms are characterized by disorganization in thought, behavior, and speech, which are manifested as loosening of associations and reductions in cognitive and verbal coherence. Negative symptoms reflect reductions or deficiencies in normal functioning. These include blunted affect (reductions in expressive behavior, including facial expression and gesturing), alogia (lack of speech), anhedonia (reduction in interest and pleasure), avolition (reductions in goal-directed behavior), asociality (lack of involvement in social relationships), and amotivation (reductions in motivation; Andreasen, 1983), as well as a host of emotional abnormalities (i.e., increased experience of negative emotion).

Individuals with schizophrenia exhibit increased negative emotional experience (Cohen & Minor, 2010; Kring & Elis, 2013; Kring & Moran, 2008). Laboratory studies indicate that individuals with schizophrenia experience increased negative emotion in response to positive, negative, and neutral stimuli (Kring & Moran, 2008; though see Horan et al., 2006). A recent meta-analysis of laboratory studies examining emotional experience in individuals with schizophrenia confirmed these findings and found increased negative emotion in response to a range of valenced stimuli (mean weighted effect size of .72 (k = 11) for pleasant stimuli, .64 (k = 7) for neutral stimuli, and .24 (k = 9) for unpleasant stimuli; Cohen & Minor, 2010). EMA studies replicate these findings and indicate that individuals with schizophrenia experience increased negative emotion over healthy controls in daily life (A. H. Sanchez, Lavaysse, Starr, & Gard, 2014). These findings indicate that individuals with schizophrenia exhibit increased negative emotion across a number of assessment modalities. Several theories have been proposed to explain these findings. One theory is that individuals with schizophrenia exhibit deficits in emotion regulation (Cohen & Minor, 2010; Horan et al., 2006).

1.3 Emotion Regulation: A Potential Mechanism Behind the Increased Negative Emotion in Psychosis Spectrum

James Gross's model of emotion regulation posits that emotions are complex processes that can be altered across the temporal course of experience (Gross, 1998b). Emotion regulation can occur at five separate points in the stream from before the time the emotion is generated and even after an emotional response. This model is called the process model, and includes antecedent- and response-focused regulatory processes (Gross, 1998b). Antecedent-focused emotion regulation consists of strategies that occur prior to or during the emotionally evocative stimulus. These strategies include situation selection, situation modification, attentional deployment, and cognitive change. Response-focused strategies occur following the emotional stimulus, and include response modification (Gross, 1998b). These strategies vary by the level of consciousness, effort, and control necessary to implement them (Shiffrin & Schneider, 1977). Because of the complex temporal nature of emotions, as well as the varying degree of accessibility of emotion regulation strategies, it has been proposed that emotion regulation occurs with variable success, often requires several regulation strategies in tandem, and may share common mechanisms across strategies. A number of common higher-order and lower-order strategies may interact to allow for effective emotion regulation. “Top-down” mechanisms are higher-order and are comprised of cognitive change or reappraisal strategies (Otto, Misra, Prasad, & McRae, 2014). These strategies are particularly effective at regulating emotions that are evoked by stimuli that are relevant to one’s personal goals or values. “Bottom-up” mechanisms are considered lower-order and are comprised of attentional deployment.

1.3.1 Bottom-up emotion regulation strategies. Bottom-up emotion regulation strategies include attentional deployment. Specific mechanisms of attentional deployment include distraction, concentration, and rumination (Gross, 1998b). Attention can be allocated in service of goals, and conversely, what we attend to can affect our goals. If, for example, the goal is to decrease negative affect, attention may be focused on positive aspects of a situation or to another topic entirely (Gross, 1998b). Attentional deployment has been shown to be effective in a range of settings, but is particularly effective in regulating bottom-up emotional stimuli (i.e., stimulus-related physical features that are inherently emotionally valenced or meaningful on an evolutionary level, as in images of predators; McRae, Misra, Prasad, Pereira, & Gross, 2012). These strategies are effective in regulating in-the-moment emotional experience, as evidenced by reduced negative emotional experience when visual attention is directed to less arousing stimuli (Dunning & Hajcak, 2009). Bottom-up emotion regulation strategies like attentional deployment are useful at regulating bottom-up emotions, but are less effective at regulating top-down emotions.

1.3.2 Top-down emotion regulation strategies. Top-down emotion regulation includes cognitive change or reappraisal. Cognitive change strategies focus on the choice or modification of one of many meanings that may be ascertained by a situation (Gross, 1998b). Reappraisal has been shown to be a very effective emotion regulation strategy (Gross, 2002). Individuals engaging in reappraisal strategies exhibit reduced activation in brain areas associated with emotional experience, including the amygdala and insula, suggesting reduced emotional experience (Goldin, Kateri, Wiveka, & Gross, 2008). However, reappraisal is further in the temporal stream of processing of emotional stimuli proposed by Gross and colleagues; and is therefore affected by lower-level strategies like attentional deployment, situation selection, and situation modification (Gross, 1998a). Top-down emotion regulation strategies are elicited by higher-order, or situation-specific, information that requires appraisal of emotional stimuli and are less effective at regulating bottom-up emotional stimuli.

1.3.3. Integrative models of emotion regulation. Researchers have recently integrated the use of top-down and bottom-up strategies and posited that the efficacy of emotion regulation is moderated by the strategy that is employed and the type of emotion that is elicited (McRae, Misra, et al., 2012). McRae and colleagues found that top-down strategies of emotion regulation (i.e., reappraisal) were most effective in response to top-down emotional stimuli, whereas bottom-up approaches (i.e., attention deployment) were more effective in response to bottom-up emotional stimuli (McRae, Misra, et al., 2012). For example, bottom-up emotions may be elicited by spiders or snakes. Top-down emotions may be elicited by receiving a curt email from a colleague, which may be interpreted as anger. This model posits that in order for bottom-up strategies to be effective, they must be matched to the method of emotion generation. Researchers have proposed that these strategies are not used in isolation; instead, lower-level strategies contribute to, and share resources with, higher-level strategies. Researchers have hypothesized that emotion regulation is a “stream”, which would suggest that strategies that come early in the regulation stream might influence higher order strategies that come later in the stream. For example, attention may guide one’s focus toward or away from emotionally evocative stimuli, which may in turn influence reappraisal strategies. This relationship between emotion regulation mechanisms is also hypothesized to have functional consequences, in that higher- and lower-order strategies may work in tandem such that bottom-up strategies are employed automatically in order to conserve resources necessary for employing top-down strategies when necessary (McRae, Misra, et al., 2012).

1.4 Current Assessment of Emotion Regulation

Assessment of emotion regulation has taken increasingly sophisticated forms. These broadly fall into subjective, behavioral, and psychophysiological responses. Many studies assess emotion regulation by examining self-reported emotional experience prior to and after regulation using a Likert scale (e.g., Sheppes et al., 2014). Other studies have employed self-report measures that assess emotional awareness, or the ability to engage in goal-directed behavior while experiencing negative emotions, and access to effective emotion regulation strategies (Catanzaro & Mearns, 1990; Gratz & Roemer, 2004). Alternative measures examine the day-to-day use of specific emotion regulation strategies (Gross & John, 2003). Much work has been done to understand the psychophysiological correlates of emotion regulation, as well. This research focuses on corrugator electromyography, blink startle response, blood pressure, and electroencephalography (EEG; Gross, 2002) as indices of emotion regulation. These measures are valid (e.g., high correlation with self-reported emotional valence (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000) and reliable (high internal consistency and stability across trials (Moran, Jendrusina, & Moser, 2013) indices of emotion regulation. One particularly well-studied measure of effortful emotion regulation is an EEG component called the Late Positive Potential (LPP). The LPP is associated with motivated attention, and is thought to reflect the activation of motivated appetitive and defensive brain regions (Gable & Harmon-Jones, 2010).

Linguistic content of verbal reappraisal has been proposed as a measure of emotion regulation. Lexical analysis, a measure of one component of linguistic content, which counts, categorizes, and compares words to a set of dictionaries for content (Tausczik & Pennebaker, 2010), has been used to examine the words used during reappraisal of emotional stimuli (Monin, Schulz, Lemay, & Cook, 2012). Lexical analysis has been examined as a putative linguistic measure of emotional experience in several studies (e.g., Cohen et al., 2009), but until recently, has not been applied specifically to emotion regulation strategies. One recent study has applied lexical analysis as an indicator of emotion regulation. Monin and colleagues (2012) found that cognitive mechanism words (e.g., because, think, realize) and positive emotion words (e.g., happy, joy) used during a reappraisal of a negative situation were related to cardiovascular reactivity, an index of emotional arousal. These findings suggest that the words used in the reappraisal were related to the physiological experience of emotion, and provide initial validation of lexical analysis as one index of emotion regulation.

1.5 Emotion Regulation in Schizophrenia

Increased negative emotional experience in schizophrenia might reflect abnormalities in emotion regulation (Cohen & Minor, 2010; Cohen, Najolia, Brown, & Minor, 2011; Horan et al., 2006; Strauss et al., 2013). This theory is derived from the findings of increased negative emotional experience in the moment and in self-reported measures of emotional experience in individuals with schizophrenia (Cohen & Minor, 2010). Researchers have posited that the consistency of these reports across time (Kring & Elis, 2013) and assessment modalities (Cohen, Najolia, Brown, & Minor, 2011) may be explained by a global increase in negative emotion that, in the absence of effective regulation strategies, leads individuals with schizophrenia to experience increased negative emotion. This theory is supported by findings indicating that individuals with schizophrenia often report greater levels of coactivated positive and negative emotion, or ambivalence (Tremeau et al., 2009; though see Cohen, Callaway, Mitchell, Larsen, & Strauss, 2015), suggesting that this is an increase in negative emotion rather than a reduction in positive emotion. In support of the emotion regulation theory, Livingston and colleagues report that individuals with schizophrenia engage in dysfunctional emotion regulation strategies like rumination, or increased attention towards the emotional situation, as a form of emotion regulation more frequently than controls (Livingstone, Harper, & Gillanders, 2009). Other researchers have found that effective reappraisal strategies are used by controls significantly more frequently than by individuals with schizophrenia (Horan et al., 2013; van der Meer et al., 2009). These findings indicate that individuals with schizophrenia exhibit increased negative emotion, which may arise due to their use of qualitatively different or less effective methods of emotion regulation.

Recent research indicates abnormalities in psychophysiological measures of emotion regulation in individuals with schizophrenia. Strauss and colleagues found that individuals with schizophrenia exhibit deficits in top-down and bottom-up emotion regulation strategies (Strauss et al., 2014, 2013). One recent study indicated that individuals with schizophrenia evidenced similar LPP amplitudes when presented with negative and neutral descriptions of negative images (Strauss et al., 2013), suggesting that emotion regulation was ineffective. Contrast this to controls, which evidenced smaller LPP amplitudes in response to negative descriptions than neutral descriptions of negative images. The authors of this study interpret these findings as an inability of individuals with schizophrenia to down-regulate negative emotion through higher-order strategies like cognitive change or reappraisal. In another study, these authors also examined visual attentional deployment and found that individuals with schizophrenia fixate for longer on negative visual stimuli both when allowed to fixate freely, as well as when they were directed to fixate on less arousing stimuli (Strauss et al., 2014). The authors interpreted these results as evidence of a deficit in bottom-up attentional deployment in regulating negative emotion, suggesting that the properties of the negative stimuli did not elicit bottom-up emotion regulation in individuals with schizophrenia. Taken together, these findings suggest that individuals with schizophrenia may exhibit abnormalities in top-down strategies like reappraisal and in bottom-up strategies like attentional deployment.

1.6 Interactions Between Attentional Deployment and Reappraisal

Research examining the relationship between attentional deployment and reappraisal is mixed. Four studies have examined the relationship between visual attentional deployment and reappraisal (Bebko, Franconeri, Ochsner, & Chiao, 2011, 2014; Urry, 2010; van Reekum et al., 2007). On one hand, Bebko and colleagues (2011) reported that attentional deployment varies as a function of emotion regulation strategies and that visual attention is one important key in the efficacy of emotion regulation. Similarly, van Reekum and colleagues (2007) report that gaze patterns varied as a function of emotion regulation task and that these gaze patterns accounted for a significant amount of the variance in activation in brain areas associated with emotion regulation (i.e., the PFC and the amygdala). On the other hand, in a later study, Bebko and colleagues (2014) reported that attentional deployment was not causal of self-reported efficacy of reappraisal or expressive suppression strategies. Additionally, Urry (2010) reports that even when holding gaze constant, reappraisal, and not attentional deployment, was responsible in prompting cognitive change, suggesting that visual attention may have less influence upon reappraisal. As a whole, this research indicates that attentional deployment may be partially responsible for influencing the specific emotion regulation strategy employed, as well as for the efficacy of the strategy employed.

The literature examining attentional deployment and reappraisal requires several caveats. First, the dependent variable of interest in both studies that found modest or no relationships between attentional deployment and reappraisal was composed of self-reported efficacy of emotion regulation strategies (i.e., Bebko et al., 2014; Urry, 2010), whereas the dependent variable in the studies that found a significant relationship was brain activation (i.e., Bebko et al., 2011; van Reekum, 2007). Importantly, studies examining brain activation and emotion regulation indicate that while both suppression and reappraisal are associated with reductions in subjective emotional experience, only reappraisal was related to reduced activity in the insula and amygdala; Goldin et al., 2008), suggesting that neural mechanisms do not always correspond completely with self-reported emotion regulation. Moreover, individuals with schizophrenia exhibit abnormal emotion-cognition interactions (i.e., abnormal prefrontal regulatory mechanisms linking emotion and goal related behavior; Ursu et al., 2011), suggesting that these strategies may be differentially related in individuals schizophrenia than in controls. As previously mentioned, prior studies have demonstrated that individuals with schizophrenia use different emotion regulation strategies than controls (van der Meer et al., 2009), indicating that these strategies may work somewhat differently in individuals with schizophrenia than in controls. A better understanding of these interactions may yield a better understanding of emotion regulation in schizophrenia. However, recent research has posited that attentional deployment alone is insufficient to explain the variability in reappraisal (Bebko et al., 2014), and has posited that cognitive control is an important mediator of emotion regulation (Ochsner & Gross, 2005).

1.7 Cognitive Control: A Potential Mediator of Emotion Regulation in Schizophrenia

Cognitive control is a set of processes involved in carrying out goal-directed behavior in the face of conflict (Miller & Cohen, 2001). This higher order construct subsumes a set of basic lower-order cognitive processes that allow flexible goal-dependent information processing and behavior (Morton, Ezekiel, & Wilk, 2011). Cognitive control is theorized to encompass a range of motivated behaviors, including overcoming prepotent responses (e.g., speaking out during a meeting because you are bored) and ignoring irrelevant stimuli (e.g., ignoring every car that is not the color of your car when searching for your car in a parking lot), among others. Cognitive control has been hypothesized to encompass systems including working memory, attention, episodic memory, language production, and comprehension, to name a few (see Miller & Cohen, 2001 for a review). Lesh and colleagues propose that cognitive control deficits parsimoniously account for a range of cognitive deficits in schizophrenia (Lesh, Niendam, Minzenberg, & Carter, 2011), suggesting that cognitive control may be useful in characterizing a range of seemingly unrelated behaviors.

Goal maintenance has been posited as one central component of cognitive control (Braver, 2012). Goal maintenance is a subcomponent of working memory, defined as the ability to represent and maintain context-related information, which utilizes prior task-related information that can bias selection of appropriate behavioral responses (Barch et al., 2004). A number of lower-order cognitive processes, including attention, active memory (online maintenance of task-relevant information), and inhibition (Barch, Carter, MacDonald, Braver, & Cohen, 2003) are subsumed within this construct. Accordingly, deficits in goal maintenance (stemming from the Dorsolateral Prefrontal Cortex) have been implicated in each of these lower-order domains (Braver & Cohen, 1999). Clinically, deficits in goal maintenance manifest as increased disorganized speech and poverty of speech (Becker, Cicero, Cowan, & Kerns, 2012). These deficits can be elicited by performance on laboratory based cognitive neuroscience tasks, including the AX Continuous Performance Task (AX-CPT), the Stroop Task, and the Lexical Disambiguation Task (Cohen, Barch, Carter, & Servan-Schreiber, 1999). These laboratory tasks each draw heavily on the use of context information to support the execution of weakly related task-appropriate responses (Cohen, Barch, Carter, & Servan-Schreiber, 1999).

Researchers have posited that goal maintenance is important in understanding emotional abnormalities in schizophrenia (Kring & Elis, 2013). Given the overlap of cognitive demands utilized during these processes, goal maintenance is posited as an important component of emotion regulation (McClure, Botvinick, Yeung, Green, & Cohen 2007). Further, researchers posit that emotion regulation processes are subsumed by the same brain regions as the brain regions associated with the cognitive control systems (i.e., Prefrontal and Cingulate control systems). In support of this, neuroimaging studies indicate that brain regions associated with cognitive control (lateral and medial Prefrontal regions) are also implicated during cognitive reappraisal strategies in healthy adults while engaged in reappraisal of negative images (Ochsner, Bunge, Gross, & Gabrieli, 2002). The goals of emotion regulation require the mechanisms necessary for cognitive control (i.e., attention, working memory). Ochsner and Gross (2005) posit that the two main components of cognitive control of emotion include attention to, and collectively changing the meaning of, emotionally evocative stimuli. This component of cognitive control is thought to include the augmentation of goal-relevant stimuli or semantic associations and the allocation of cognitive resources to goal-relevant representations, while unwanted emotional information is indirectly suppressed (Greening, Lee, & Mather, 2014). Cognitive control may therefore account for a portion of the variance in emotion regulation; and abnormalities in cognitive control may explain the abnormalities in emotion regulation exhibited by individuals with schizophrenia.

Individuals with schizophrenia exhibit deficits in several domains of cognitive control, as well as in emotion regulation. Given the overlap in brain circuitry related to cognitive control and emotion regulation, it follows that cognitive control may be a particularly important mechanism for, or may reflect overlap in the mechanisms associated with, emotion regulation in individuals with schizophrenia. However, there has been little experimental research examining the role of cognitive control on emotion regulation in individuals with schizophrenia, and the findings in this area somewhat inconsistent. One recent study posited that cognitive control was necessary for emotion regulation; that cognitive control (as indexed by pupillary diameter) was associated with deficits in emotion regulation (as indexed by LPP amplitude); and posited that top-down cognitive control may be important in directing lower order attentional deployment towards less salient information and inhibiting the processing of goal-irrelevant arousing information (Strauss et al., 2014). However, another study concluded that a generalized deficit in cognitive control could not fully account for the abnormalities in LPP amplitude (Strauss et al., 2013). These studies indicate that individuals with schizophrenia evidence deficits in cognitive control as well as emotion regulation, but evidence for the relationship between cognitive control and emotion regulation is mixed. Prior studies have focused on cognitive control more generally, with only a handful of studies including measures of goal maintenance. Furthermore, these studies have examined the relationship between goal maintenance and psychophysiological measures of emotion regulation, but no studies have examined goal maintenance as a mediating variable between attention deployment and reappraisal. These findings indicate the importance of understanding the relationship between goal maintenance and emotion regulation in individuals with schizophrenia.

1.8 Current Study

Prior research has posited the importance of the relationships among emotion regulation strategies, as well as the importance of goal maintenance in each of these strategies. No studies to our knowledge have examined the mediating role of goal maintenance among emotion regulation strategies in individuals with schizophrenia. Additionally, these studies utilize laboratory procedures that, while useful, lack ecological validity. The current study seeks to use a novel experimental paradigm to examine the role of goal maintenance on emotion regulation in schizophrenia. Further, we seek to employ an ecologically valid objective lexical analysis of speech to examine the linguistic properties of emotion regulation.

1.9 Research Questions and Hypotheses

1.9.1 Aim 1. Because lexical analysis is a relatively novel index of emotion regulation, it is important to validate this measure against a common measure of emotion regulation. The first aim of the current study is to examine the relationship between the number of emotional words used during reappraisal and Likert scale ratings of emotional experience. It is hypothesized that ratings of emotional experience will correlate positively with the number of emotional words used in the appraisals.

1.9.2 Aim 2. The relationship between cognitive control and attentional deployment has been established (Barch et al., 2004). Prior research indicates a hierarchical relationship between lower order cognitive mechanisms and cognitive control. We seek to replicate this finding in the current study. Therefore, the second aim is to examine the relationship between attentional deployment and cognitive control. Given the putatively hierarchical relationship between attentional processes more generally and cognitive control, it is hypothesized that attentional deployment will be positively related to cognitive control.

1.9.3 Aim 3. Research examining the relationship between attentional deployment and reappraisal posits that reappraisal is partially affected by attentional allocation, but this relationship is yet unclear. Clarifying this relationship would provide important information about the emotion regulation stream and how these emotion regulation strategies are used in individuals with schizophrenia. The third aim of the current study is to examine the relationship between attentional deployment and reappraisal. It is hypothesized that attentional deployment will be positively related to reappraisal.

1.9.4 Aim 4. Ochsner and colleagues (2002) have demonstrated the relationship between cognitive control and emotion regulation, but this has not been examined in individuals with schizophrenia. This is important in that individuals with schizophrenia exhibit abnormalities in cognitive control, which may be responsible for deficits in reappraisal. The fourth aim is to examine the relationship between cognitive control and reappraisal. Given prior research examining cognitive control and emotion regulation, as well as the finding that disorganized speech is related with poor cognitive control, it is hypothesized that cognitive control will be positively related to measures of verbal reappraisal in individuals with schizophrenia.

1.9.5 Aim 5. The mediating role of cognitive control between higher- and lower-order emotion regulation strategies has not been yet examined. Understanding this relationship may help to clarify the increased negative emotional experience in individuals with schizophrenia. The fifth aim is to examine the mediating role of goal maintenance on the relationship between attentional deployment and reappraisal. Given the prior literature linking neural activation of cognitive control and emotion regulation more generally, it is hypothesized that goal maintenance will be a significant partial mediator of the relationship between attentional deployment and reappraisal.

1.10 Potential Implications (Rationale for the Current Study)

Current research has posited that both attentional deployment and reappraisal are deficient in individuals with schizophrenia, but there is no research examining the relationship between these mechanisms. If these strategies are part of a temporal stream where lower-order strategies affect higher order strategies as hypothesized by the process model of emotion regulation, then it is possible that lower order emotion regulation strategies may contribute to the abnormalities in higher-order emotion regulation strategies. It is unclear whether abnormalities in higher-order strategies occur independently of the deficits in lower-order strategies, or whether they are abnormal at least partially because of the abnormalities in lower-order strategies. The current study therefore seeks to disentangle the relative contribution of lower-order emotion regulation strategies (i.e., attentional deployment) in higher-order emotion regulation by eliciting reappraisals of negative stimuli, while manipulating attentional deployment.

Understanding the relationship between emotion regulation strategies and cognitive control in schizophrenia is important because it may clarify the relationships among emotion regulation strategies and potentially, the mechanism behind the increase in negative emotional experience in schizophrenia more generally. Clarification of the relationship between attentional deployment and reappraisal is of interest in that our current understanding of emotion regulation in schizophrenia may be incomplete due to mismatch between tasks and emotion regulation strategies (e.g., using bottom-up emotion generation to elicit top-down regulation strategies). Moreover, these processes have been largely been examined in isolation, leading to potentially spurious conclusions regarding how they may operate due to important interactions among emotion regulation strategies that may not be accounted for. Finally, understanding the relationship among emotion regulation mechanisms and cognitive control may allow for effective intervention into the processes of emotion regulation in individuals with schizophrenia.

CHAPTER 2. METHOD

2.1 Participants

Participants consisted of 27 individuals diagnosed with psychotic disorders (17 participants diagnosed with schizophrenia and 7 participants diagnosed with schizoaffective disorder) or psychotic mood disorders (2 participants diagnosed with Bipolar Disorder, with psychotic features and 1 participant with Major Depressive Disorder, with psychotic features). From this initial sample of 27 participants, 23 participants were analyzed for the current analyses, due to incomplete data for 5 participants. The reasons for incomplete data included 2 participants who refused to complete the emotion regulation task because it was deemed too distressing and 3 participants for whom adequate calibration of the eye-tracker was not achieved, and thus insufficient data were collected (see section labeled "Eye-tracking Apparatus" for potential explanations regarding difficulty in calibration). Recruitment timeline and population constraints required that we expand our criteria to include individuals with diagnoses of schizophrenia and schizoaffective disorder, as well as other psychotic mood disorders. Our final sample therefore consisted of 15 individuals diagnosed with schizophrenia, 5 individuals diagnosed with schizoaffective disorder, and 3 participants with psychotic mood disorders (2 participants with Bipolar I Disorder, with psychotic features, and 1 participant with Major Depressive Disorder, with psychotic features). Participants were recruited from several local group homes and outpatient clinics as part of a larger study. Diagnoses were made using the Structured Clinical Interview for DSM 5 (SCID-5) under the supervision of a licensed clinical psychologist (Alex Cohen, Ph.D.) in conjunction with review of available medical records when these records were available. Diagnoses were confirmed via independent consensus ratings wherein a blind rater viewed the video of the diagnostic interviews and rated each participant independently. Instances in which these discrepancies were equal to or greater than a 2-point difference across raters were discussed in a weekly case conference to ensure that consensus was met within the group.

2.2 Emotion Regulation Task

Participants were administered a modified emotion regulation task that has been used in several iterations (e.g., Bebko et al., 2011). The emotion regulation task featured several modifications of the original paradigm in order to assess the role of attentional deployment on reappraisal. Prior to seeing the two images, a sentence was displayed to provide context to the two images, and to establish the images as part of a common storyline (see Figure 1 for a schematic of the emotion regulation task). This task was separated into four phases and lasted approximately 15-18 minutes.

2.2.1 Stimuli. A set of 26 pairs of emotionally valenced stimuli compiled from Internet searches was presented side-by-side on a computer monitor using Tobii Studio, an integrated eye-tracking and stimulus presentation software (Version 3.2; Tobii Technologies AB). Each set of images featured one negative image and one positive reappraisal image (i.e., featuring a positive image that was thematically related to the negative stimulus), resulting in 13 matched scene slides. See Appendix A for a list of the themes and prompts. These slides were prepared using GNU Image Manipulation Program (Version 2.18.8). Next, the slides were processed individually using Tobii Studio to mark Areas of Interest (AOIs), which acted as a boundary wherein eye metrics were measured. AOIs were demarcated such that participants could not observe their presence. AOIs included rectangles that subsumed the entire positive image and the entire negative image. Additional AOIs were marked within each positive and negative image in order to denote the primary subject of the stimulus for future analyses (see Figure 1 for an example of the AOIs overlaid on an example stimulus).

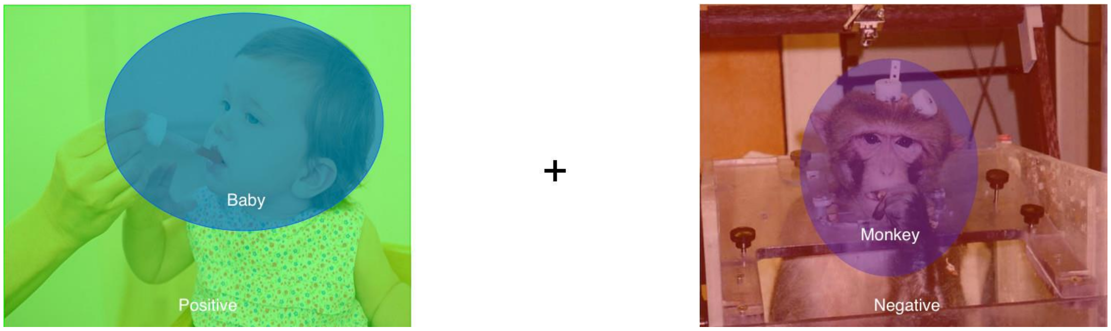

Figure 1. Example of general (green/red) and specific (blue/purple) AOI on stimulus.

2.2.2 Viewing Phase. During the viewing phase (phase 1), emotionally valenced stimuli were presented side-by-side on a computer monitor for 5 seconds. Following the initial verbal prompt and image presentation, participants were prompted to rate their emotional experience on two discrete Likert scales (i.e., 0-9 scales for positive and negative affect, respectively; phase 2).

2.2.3 Reappraisal Phase. The reappraisal phase (phase 3) followed the viewing phase. During the reappraisal phase, participants were presented both images for 30 seconds with AOIs superimposed on each image so that eye-metrics could be calculated. During the reappraisal phase, participants were allowed to freely view both the negative and the reappraisal image. Participants were verbally and visually prompted to reappraise each set of images (i.e., "tell a story about images that makes you feel better"; adapted from Bebko et al., 2011). During this phase, participants were directed to continue verbally reappraising the images, speaking as much as possible. Following the reappraisal, participants rated their emotional experience for a final time with a set of discrete Likert scale measures of emotional experience (i.e., same positive and negative scales from the Viewing Phase; phase 4).

2.3 Eye-tracking Apparatus

Eye-movements were recorded using a Tobii TX-300 eye-tracker. The eye tracker was controlled by a Dell OptiPlex 745 desktop computer, which simultaneously recorded event codes and presented the task stimuli. A 9-point calibration was performed prior to the experiment. Images were displayed on a 23-in. LCD monitor (1920 X 1080 resolution) located approximately 65 cm from participants' eyes using Tobii Studio software suite. Weighted percentage of samples was analyzed for each sample as a measure of the quality of the gaze samples collected by the eye-tracker. In total, the average weighted percentage of samples collected across participants was 67.14 (18.13). 8 participants from the original sample of 27 participants exhibited weighted total gaze samples below 50%. Of these 8 participants, 4 participants did not calibrate at all, and therefore obtained no usable data. The cause of variability in quality of eye-tracking data collection was due largely to variations in eye color, facial physiognomy, and whether the participant was wearing glasses or contacts, as well as variations in natural ambient light as a function of room (Tobii, 2016). In particular, individuals with greater melanin production yielded poorer recording quality than individuals with less melanin. Movement disorder precluded one participant from calibrating on the eye-tracking task. Given the relatively low sample size of the current study, the 4 participants who exhibited weighted sample percentages below 50% but above 0% were used in the below analyses. The overall pattern of findings did not change when including and excluding these participants.

2.3.1 Eye-tracking variables. Tobii Studio was used to calculate eye-tracking metrics designed to characterize eye-movements based upon the above-defined AOIs for stimuli presented during the reappraisal phase of the task. The principle metric of interest in the current study was Total Visit Duration (in seconds), defined as the total duration of all visits within an active AOI. Separate summary variables were computed based upon the valence of the image (i.e., positive or negative image). These were averaged across all positive and negative stimuli, respectively. A measure of attentional bias was calculated to encompass the total gaze in the negative and positive stimuli. For this variable, the Total Visit Duration on negative stimuli was divided by the Total Visit Duration on the positive stimuli in order to obtain a single score that was used to summarize the amount of time spent looking at each stimulus. Numbers greater than 1 indicated longer visit time on negative stimuli than positive stimuli and numbers between 0 and 1 indicated longer visit time on positive stimuli than negative stimuli.

2.4 Procedure

Participants completed the emotion regulation task as part of a larger battery, consisting of computer tasks, pencil and paper testing, and a clinical interview. After providing written informed consent, participants were administered one practice trial of the Emotion Regulation task with detailed written and verbal instructions for two example images and a corresponding example reappraisal, in order to facilitate understanding of the written instructions. Next, 13 trials of the emotion regulation task were presented, totaling approximately 20 minutes. Because the stimulus intensity has been shown to influence the emotion regulation strategy used (Shafir, Thiruchselvam, Suri, Gross, & Sheppes, 2016), thereby impacting the effectiveness of emotion regulation, a final separate task related to the emotion regulation task prompted participants to rate the intensity, as well as the positive and negative valence of each stimulus. These stimuli were randomly presented individually (rather than in corresponding pairs with the negative image and the regulation image). Following the emotion regulation task, participants were administered the remaining measures in the research protocol, including the AX-CPT, structured clinical interviews, and self-report measures.

2.5 Clinical Rating Scales

2.5.1 Structured Clinical Interview for DSM – 5th edition (SCID-5). The SCID-5 research version was administered to participants during the diagnostic interview. The SCID-5 is a semi-structured diagnostic interview designed to assess a range of psychiatric disorders, based upon DSM-5 diagnostic criteria (First, Williams, Karg, & Spitzer, 2015). While the SCID-5 is a relatively new instrument, inter-rater agreement is generally high for previous versions of the SCID (e.g., SCID-IV; ranging from .60 for agoraphobia to .81 for dysthymia, and the sensitivity for diagnosing schizophrenia spectrum disorders is 53%, whereas the specificity is 97%; Nordgaard, Revsbech, Sæbye, & Parnas, 2012). There have been several changes to the diagnostic criteria in the SCID-5 from pervious versions, but generally, the SCID is one of the most common structured clinical interviews due to its long history of use and psychometric properties.

2.5.2 Brief Psychiatric Rating Scale (BPRS). The BPRS was administered to participants during a clinical interview in order to assess global symptom severity. The BPRS is a 24-item clinician-rated symptom scale, that takes approximately 20 minutes to administer, and measures psychotic symptoms (positive, negative, and disorganized), as well as mood symptoms (mania and depression) and anxiety. The BPRS is a four-factor instrument, consisting of manic excitement, negative symptoms, positive symptoms, and depression/anxiety (Ventura, Nuechterlein, Subotnik, Gutkind, & Gilbert, 2000). The inter-rater agreement of the BPRS is high (r = .82; Targum et al., 2015), and the BPRS has concurrent validity with Clinical Global Impression scores in predicting recovery (Leucht et al., 2005).

2.5.3 Brief Negative Symptom Scale (BNSS). The Brief Negative Symptom Scale (BNSS) was administered to participants during a clinical interview to assess the severity of negative symptoms. The BNSS is a 13-item clinical interview, which takes 10 to 15 minutes to administer (Strauss & Gold, 2016). It has been recommended by the National Institutes of Mental Health as a measure of negative symptoms, including anhedonia, asociality, avolition, blunted affect, alogia, and normal distress (Carpenter, Blanchard, & Kirkpatrick, 2015). Interrater agreement is good (*r*'s ranging from .89 to .96; Kirkpatrick et al., 2011). Temporal stability is also good (*r*'s = .77 to .90). The BNSS exhibits good concurrent (*r* = .84 with SANS total negative symptoms), and discriminant (*r* = .14 with PANSS depression) validity (Kirkpatrick et al., 2011). It also exhibited good predictive validity (*r* = .60 with Clincal Global Impression; Kirkpatrick et al., 2011).

Current symptom ratings for the BNSS and BPRS were scored by the interviewer who completed the assessment. All raters were trained to acceptable levels of interrater reliability. Digital video recordings for a subset of 53% of these participants were submitted to rating by a blinded graduate student in order to achieve clinical consensus. After this subset of blind reliability ratings was made, a case conference was held to identify discrepancies between raters. Because no significant discrepancies were identified between raters, the remaining 47% of digital video recordings of BNSS and BPRS interviews were not submitted to blind ratings.

2.6 Measures of Emotion Regulation

2.6.1 Self-reported negative affect. One commonly used index of emotion regulation and emotional experience, more generally, is self-reported emotional experience (e.g., Chiesa, Serretti, & Jakobsen, 2013; Gross, 1998a; Morillas-Romero, Tortella-Feliu, Balle, & Bornas, 2015; van Reekum et al., 2007). We assessed effectiveness of emotion regulation by querying self-reported emotion using a set of two 9-point Likert scales from 1 to 9. Self-Assessment Mannequin (SAM; Bradley & Lang, 1994) images accompanied the numeric ratings of emotional experience as anchors at numbers 1 and 9 in order to further facilitate understanding of the rating scale. Participants were prompted to respond via a key press to report how positive, and how negative they feel, following the initial viewing phase and following the reappraisal phase. Two separate change scores were computed by subtracting positive and negative affective ratings prior to the reappraisal phase from positive and negative affective ratings following the reappraisal phase to determine the effect of reappraisal on positive and negative emotional experience, respectively. The change score for positive affective ratings was calculated by subtracting pre-reappraisal scores from post-reappraisal scores, due to the hypothesized positive change as the result of emotion reappraisal. For the positive valence scale, positive numbers indicated an increase in positive affect and negative numbers indicated reductions in positive affect. Negative affective ratings were calculated in the inverse, subtracting post-reappraisal scores from pre-reappraisal scores due to the hypothesized negative change as a result of reappraisal strategies. In the negative valence scale, positive numbers indicated a decrease in negative affect and negative numbers indicated an increase in negative affect. In each of these metrics, negative numbers indicated that the participant did not benefit from reappraisal, and evidenced a decrease in positive affect or an increase in negative affect, respectively. As indicated in the results, change in positive ratings but not in negative ratings varied significantly as a function of reappraisal. Therefore, change in the positive valence scale was utilized as the primary self-reported measure of emotion regulation.

2.6.2 Lexical analysis of verbal reappraisal. The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) is a measure of self-reported habitual use of reappraisal and suppression emotion regulation strategies in everyday life. The scale is 10 items long (6 items examining reappraisal and 4 examining suppression). Responses to the ERQ take the form of

Likert scores ranging from 1 (strongly disagree) to 7 (strongly agree). The ERQ is a two-factor scale with cognitive reappraisal and expressive suppression coalescing as separate factors (Gross & John, 2003). The reappraisal scale has a coefficient alpha of .79 and the expressive suppression scale has a coefficient alpha of .73 (Gross & John, 2003). The ERQ exhibits incremental validity over measures of neuroticism and other personality factors (i.e., Big 5 personality factors; Ioannidis & Siegling, 2015), indicating that its use as a measure of emotion regulation is valid.

2.6.3 Self-reported emotion regulation. The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) is a measure of self-reported habitual use of reappraisal and suppression emotion regulation strategies in everyday life. The scale is 10 items long (6 items examining reappraisal and 4 examining suppression). Responses to the ERQ take the form of Likert scores ranging from 1 (strongly disagree) to 7 (strongly agree). The ERQ is a two-factor scale with cognitive reappraisal and expressive suppression coalescing as separate factors (Gross & John, 2003). The reappraisal scale has a coefficient alpha of .79 and the expressive suppression scale has a coefficient alpha of .73 (Gross & John, 2003). The ERQ exhibits incremental validity over measures of neuroticism and other personality factors (i.e., Big 5 personality factors; Ioannidis & Siegling, 2015), indicating that its use as a measure of emotion regulation is valid.

2.7 Cognitive Control

2.7.1 Continuous Performance Task. Cognitive control was measured using a commonly used cognitive neuroscience paradigm called the AX Continuous Performance Task (AX-CPT; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956). This has recently been applied to individuals with schizophrenia (MacDonald, 2008). The AX-CPT is similar to standard CPT programs, in that participants are required to signal when they see a given target (usually an X from a serially presented set of letters). The AX-CPT differs from the traditional CPT paradigm because in the AX-CPT, participants are required to respond to X's only when they are preceded by A's (Riccio, Reynolds, Lowe, & Moore, 2002). There is considerable evidence indicating that the AX-CPT is a valid measure of goal maintenance. The dorsolateral prefrontal cortex, a region traditionally associated with goal maintenance, has been linked to AX-CPT performance in several neuroimaging studies (Lopez-Garcia et al., 2016). The AX-CPT has been recommended by the Cognitive Neuroscience Treatment Research to Improve Cognition in Schizophrenia (CNTRICS) initiative as a valid measure of goal maintenance (Barch et al., 2009). This task is a useful measure of goal maintenance because within the task are contextual cues that interact with target response biases (Barch et al., 2003) and must be maintained by participants. This is achieved through interference targets. For example, if a target is preceded by any other letter, participants should not respond (called "BX" trials). Further, if any other letter follows an A, the participant should not respond (called "AY" trials). Finally, participants are not to respond to the baseline trial type, which occurs when a non-A letter precedes a non-target (called "BY" trials). Performance on the AX-CPT was measured by a common summary variable taken from the signal detection theory literature, d', or the discriminability index. *d'* is a summary variable examining hit rates of the AX trials and false alarm rates of the BX trials, which measures how well the observer is able to correctly respond to the correct stimuli while correctly avoiding the incorrect ones.

2.8 Data Analyses

2.8.1 Manipulation Checks. The first set of manipulation checks was designed to clarify whether the reappraisal task was effective on a subjective level. Two separate dependent samples t-tests were computed in order to examine whether positive and negative Likert ratings of emotional experience differed from pre- to post-reappraisal. These analyses clarified whether participants endorsed a subjective experience of emotion regulation. Evidence that this manipulation of mood was effective would be a reduction in self-reported negative affect and/or an increase in self-reported positive affect as a function of reappraisal.

A second manipulation was designed to clarify whether this subjective experience of emotion regulation was associated with the lexical measures of emotion regulation. A set of Pearson correlations was conducted to examine the relationship between the number of emotional and cognitive mechanism words used and the mean difference score of positive and negative Likert scale measures of emotion experience prior to and after reappraisal. Evidence that this manipulation was successful would be a significant correlation between changes in self-reported affect with cognitive mechanism and affective word use, respectively.

A third set of manipulation checks utilized a final set of Pearson correlations to examine the relationship between the eye-tracking variable of attentional deployment and both the lexical and self-reported indices of emotion regulation. Evidence that this manipulation check was successful would be significant correlations between our eye-tracking variable of attentional deployment and lexical and self-reported indices of emotion regulation.

2.8.2 Mediation Analyses. The primary aims of this study (e.g., aims 2 through 5) were analyzed using a set of bias-corrected bootstrap mediation computed by the PROCESS macro for SPSS (Hayes, 2017). A set of mean-centered regression analyses examined the relationship between the relationship between attentional deployment and reappraisal (path *c'*); the relationship between attentional deployment performance and goal maintenance (path *a*); and the relationship between goal maintenance and reappraisal (path *b*) were tested prior to examining the mediating effect of cognitive control on this relationship. The indirect effect of goal maintenance was then calculated for each model using a bias corrected bootstrap with 95% confidence intervals to examine the mediating effect of goal maintenance on the relationship between attentional deployment and reappraisal. The data were resampled 5,000 times. As recommended by Hayes (2017) the Completely Standardized Effect, created by standardizing each the predictor and the outcome (denoted as *cs* subscript), was used as an effect size on the *c',* and *ab* paths of the simple mediation analyses as a means of comparing the relative strength of the direct and indirect effect across models. In instances where effect sizes are not denoted (steps *a* and *b*), the variables within the model (i.e., our measure of attentional deployment and cognitive control) are identical across our models. Thus, unstandardized regression weights provide a relative measure of the magnitude of the relationship between attentional deployment and cognitive control, and of the relationship between cognitive control and each respective measure of reappraisal (Hayes, 2017).

Two sets of mediation analyses were conducted examining as outcomes lexical indices of emotion regulation and change in self-reported positive affect, respectively. Attentional deployment during the modified emotion regulation task (as indexed by our measure of attentional bias) served as the predictor variable for both models. d' was used as the mediating variable in both models. The outcome variables measuring emotion regulation effectiveness in these mediation analyses included lexical analysis of speech variables (positive words, negative words, cognitive mechanism words) and self-reported change in affect (rating 1-9 before and after the reappraisal phase). See Figure 2 for a schematic clarifying visually the two sets of mediation analyses. Given that there was no significant difference in negative ratings as a result of the emotion regulation task, but there was a significant change in positive ratings of stimuli, ratings of positive emotional experience were utilized as the primary outcome variable for this second set of analyses. However, because change in self-reported negative affect was significantly correlated with both positive and negative word use, suggesting it may exhibit superior construct validity over change in self-reported positive affect, change in negative affect was used as a secondary outcome measure with similar results. These results are summarized in Appendix C.

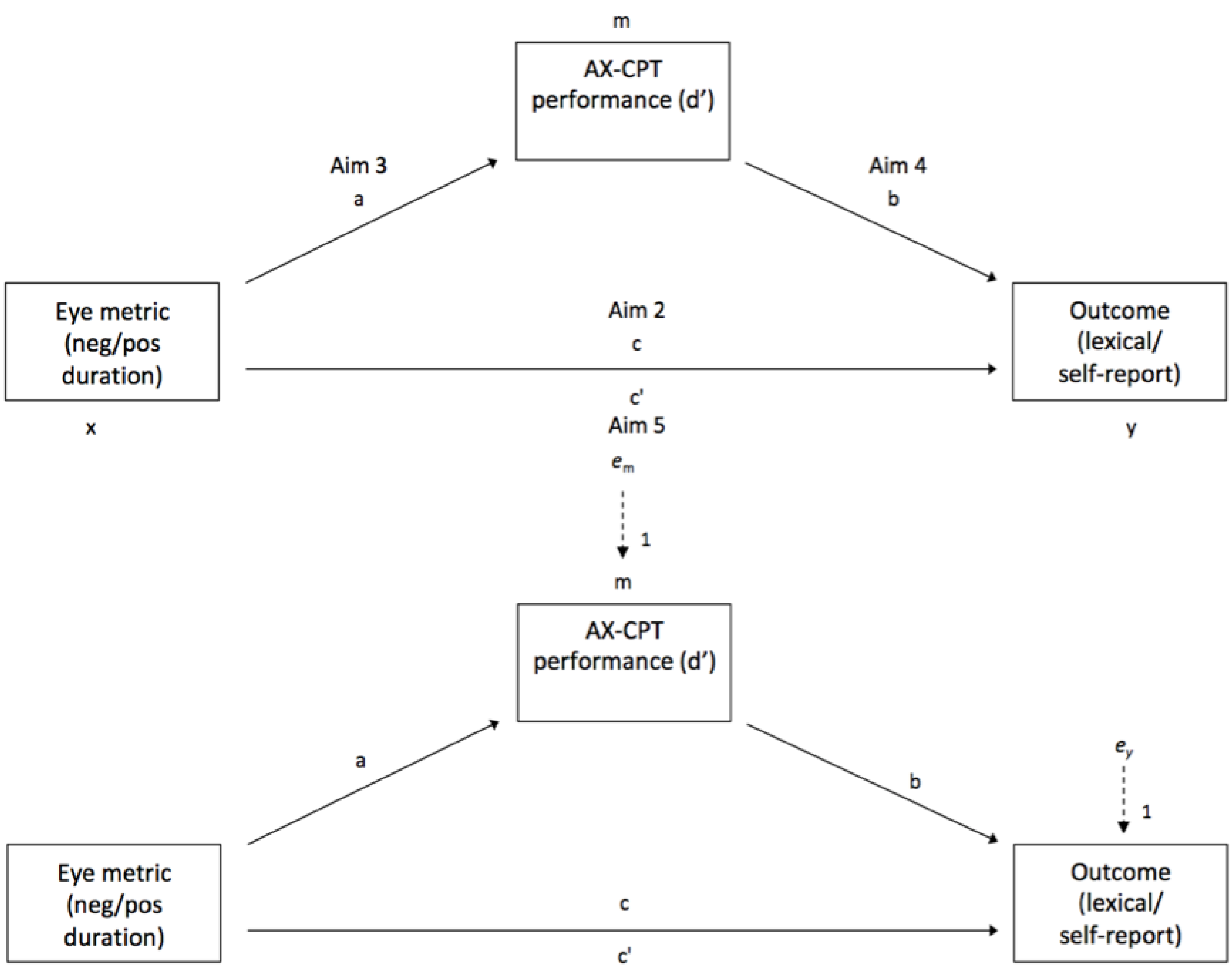

Figure 2. Theoretical and Statistical Models of Simple Mediation

2.8.2.1 Lexical analyses. The relationship between attentional deployment and cognitive control was examined by regression analysis, where attentional deployment was the predictor and AX-CPT d' was the criterion. The relationship between attentional deployment and the lexical measures of emotion regulation was examined by a second regression analysis, where attentional deployment performance was the predictor and lexical measures of emotion regulation (i.e., cognitive mechanism word use, affective word use) were the criterion. The relationship between cognitive control and the emotion regulation was examined using a third regression analysis, where AX-CPT d' was the predictor and lexical measures of emotion regulation were the criterion. The mediating role of cognitive control was examined using the bias corrected bootstrap, using 95% confidence intervals (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2008).

2.8.2.2 Subjective emotional experience. The relationship between attentional deployment performance and cognitive control was examined by regression analysis, where attentional deployment performance was the predictor and AX-CPT d' was the criterion. The relationship between attentional deployment and self-reported emotion regulation was examined by a second regression analysis, where attentional deployment performance was the predictor and the Likert scale difference score in self-reported positive affect was the criterion. The relationship between cognitive control and emotion regulation was examined using a third regression analysis, where AX-CPT d' was the predictor and Likert scale difference score in self-reported positive affect was the criterion. The mediating role of cognitive control was examined using the bias corrected bootstrap, using 95% confidence intervals (MacKinnon et al., 2004; Preacher & Hayes, 2008).

Because the outcome variable was the only variable changing across analyses, the above mediation analyses were repeated with the respective outcome variables of self-reported change in positive affect and the lexical indices of reappraisal standardized in order to directly compare the relative weights of each predictor. These analyses allowed for clarification of which of these outcome variables were most strongly related to the eye-tracking variable of attentional deployment using a commonly scaled metric. In order to clarify whether these standardized weights were significantly different from one another, per Clogg, Petkova, & Haritou (1995) a set of z-tests were performed on a subset of these standardized beta weights, including one set comparing the various lexical measures of emotion regulation with change in positive affect. Another z-test compared the weights of both change in positive and change in negative self-reported affect.

2.8.2.3 Post-hoc moderated mediation analyses. Given the fact that stimulus intensity has been shown to affect emotion regulation strategy use (Shafir et al., 20116), thereby potentially impacting the relationship between emotion regulation strategies, an additional set of moderated mediation analyses was conducted mirroring the above mediation analyses to examine the moderating role of individual differences in stimulus intensity in the relationship between cognitive control and reappraisal. See Figure 3 for a schematic clarifying visually the two sets of mediation analyses. Of note, self-reported stimulus intensity ratings were not collected for a subset of participants due to an error in the output files produced by E-prime. Therefore an alternative measure computed by subtracting the mean orthogonally rated negative rating of negative stimuli from the mean orthogonally rated positive rating of positive stimuli was used as a measure of individual differences in stimulus intensity across positive and negative stimuli. For this composite variable, positive scores indicated that participants rated the positively valenced stimuli as more intense than negatively valenced stimuli and negative scores indicated that participants rated the negatively valenced stimuli as more intense than positively valenced stimuli.

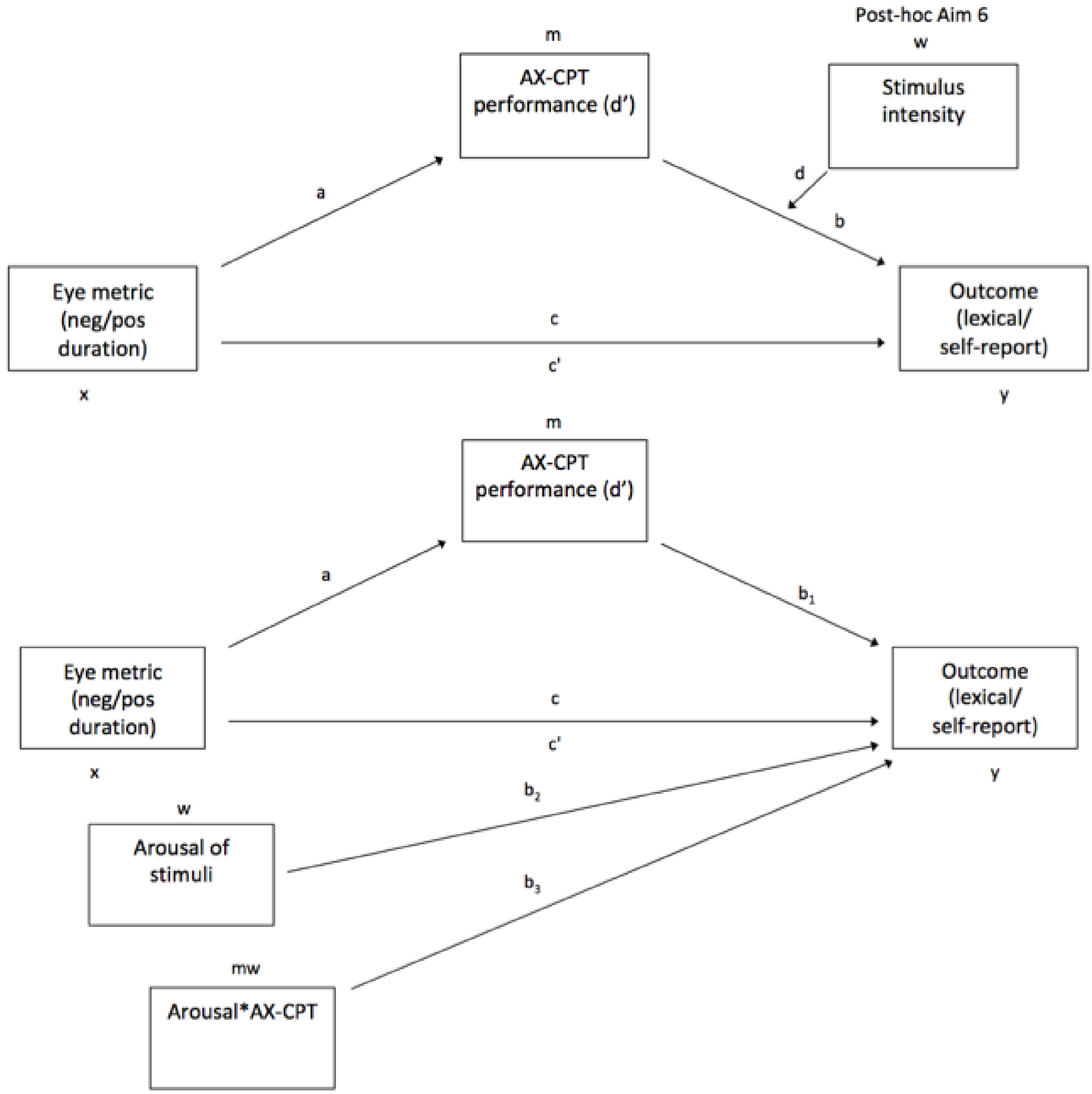

Figure 3. Theoretical and Statistical Models of Moderated Mediation

As recommended by Hayes (2015), inferential statistics analyzing the significance of the conditional indirect effect in each of these models included examination of the Confidence Intervals for the Index of Moderated Mediation. These moderated mediation relationships were probed using the Johnson-Neyman method to clarify which participants and under which conditions the mediating role of cognitive control was significant and for which participants and under which conditions it was not significant (Hayes, 2017). Because the conditional indirect effects are calculated as a product of two or more paths, interpretation of effect sizes is complicated in moderated mediation models. Therefore, no standardized effect size measures were provided for the moderate mediation model. However as in the above mediation analyses (path *a* and *b*), because the predictor remained constant across the post-hoc moderated mediation analyses with only the outcome variable differing across each model, the relative magnitude of each coefficient was used as a measure of relative effect size.

2.8.2.4 Exploratory analyses. A set of Pearson correlations examined the relationship self-reported emotion regulation, positive, negative, and cognitive mechanism word use, goal maintenance, and the separate symptom domains of schizophrenia, as measured by the BPRS and BNSS.

2.9 Power Analysis

Based on guidelines used to obtain adequate power to detect a mediated effect ($\beta = .80$) by Fritz and MacKinnon (2007) the current study sought to recruit approximately 43 participants. Examining the individual regression analyses that comprised the mediation model allowed for a set of power analyses that takes into account the number of participants required for each specific analysis, rather than the omnibus analysis. Prior analyses examining the relationships between attentional deployment and cognitive control indicate a large effect ($r = .54$; Barch et al., 2004), suggesting that the required sample for this component of the model was 24 participants. Analyses examining the relationship between cognitive control and reappraisal indicate a medium to large effect ($r = .26$; McRae, Jacobs, Ray, John, & Gross, 2012 to $r = .35$; Sullivan and Strauss, 2017), suggesting that the required sample for this component of the model was approximately 73. Given that cognitive control is expected to be positively related to attentional deployment, a one-tailed test is appropriate, reducing the participants required for adequate power in this analysis to 61. However, one prior study examining previously depressed individuals found a large effect (*d* = 1.6; Remy, 2012) of Stroop Inhibition/Switching scores, a measure of executive functioning, on reappraisal effectiveness. While the sample in this study differed from the population of interest in the current study, this was the only study to our knowledge utilizing self-reported change in affect as an outcome measure, indicating that this outcome may be particularly strongly linked to cognitive control and therefore should be accounted for in a priori power analysis. Remy's (2012) findings suggest that the sample size required for adequate power in this component of the model was 13 participants. Research indicates that attentional capacity broadly is related to emotion regulation, and may even serve as a precursor to effective reappraisal. In particular, Manera and colleagues found that visual attention was a significant mediator in the relationship between emotion generation and reappraisal, indicating that visual attention is distinct from, but integral to reappraisal strategies (Manera, Samson, Pehrs, Lee, & Gross, 2014). Few examples exist in the literature examining the relationship between attentional deployment and reappraisal. However, van Reekum and colleagues (2007) found that visual measures of attentional deployment accounted for 35% of the variance in amygdala activity during a reappraisal task when compared to reappraisal alone. While the outcome variable used in van Reekum et al., (2007) was amygdala activity and the outcome variables in the current study were lexical and self-reported indices of emotion regulation, this is one of only three studies examining the role of gaze on reappraisal that allowed gaze to vary naturally, as was the case in the current study. This methodology was most closely tied to the methodology in the current study. Therefore, given the effect size in van Reekum's (2007) findings, 23 participants were required to achieve adequate power for this component of the model. Taken together, given the power analyses of the discrete components of the mediation model, adequate power was largely achieved for the below analyses.

CHAPTER 3. RESULTS

3.1 Demographics and Clinical Variables

Table 1 includes descriptive data related to demographic (age, ethnicity), symptom ratings (BPRS, BNSS ratings), and cognitive (AX-CPT d' scores) variables for our sample. In a pattern similar to Barch et al., 2003, performance on the AX-CPT varied as a function of trial type (proportion of correct responses for each condition of the AX-CPT located in Table 1). There was a nearly significant effect of AX-CPT trial ($F(3,19) = 3.08$; $p = .07$). Post-hoc analyses indicated that responses to AY trials were correct significantly more frequently than BX trials (mean difference = .17, $p = .04$), and responses to BY trials were correct significantly more frequently than BX trials (mean difference = .22; $p = .02$).

Table 1 Demographic and clinical characteristics

Age	48.35 (10.05)
Sex (% female)	41%
Ethnicity (% African American)	69%
Neuropsychological Assessments	
WRAT Reading Score	33.91 (10.81)
AX-CPT d' Score	.80 (1.52)
Proportion AX-CPT AX Correct	.69 (.32)
Proportion AX-CPT AY Correct	.69 (.27)
Proportion AX-CPT BX Correct	.52 (.33)
Proportion AX-CPT BY Correct	.74 (.30)
Symptom Ratings	
BNSS Total	24.32 (13.26)
Anhedonia	5.32 (3.64)
Lack of Normal Distress	1.41 (1.53)
Asociality	4.27 (1.83)
Avolition	4.45 (2.28)
Blunted Affect	5.77 (5.08)
Alogia	3.22 (3.24)
BPRS Total	44.41 (13.44)
BPRS Positive	12.86 (6.23)
BPRS Negative	11.77 (4.22)
BPRS Activation	8.09 (2.37)
BPRS Affect	10.14 (4.83)

3.2 Eye-tracking Measure of Attentional Deployment

There was a nearly significant difference between Total Visit Duration on positive (8.06 seconds (4.51)) and negative (9.06 seconds (4.57)) stimuli ($t(22) = -2.07$; $p = .05$; $d = .43$). The average composite eye-tracking measure of attentional deployment dividing negative total visit duration by positive total visit duration was 1.13 (.40), confirming the bias towards negative stimuli over positive stimuli.

3.3 Lexical Analyses

Broadly, affective words made up 5.84 (3.03) percent of words used in verbal reappraisals, with 3.56 (2.55) percent of these words being positive and 2.30 (1.22) percent of these words being negative. Cognitive mechanism words comprised 10.98 (3.78) percent of the words used in verbal reappraisals. Regarding the sub-categories of cognitive mechanism word use, Insight-related words comprised 1.97 percent (2.74) of words used. Cause-related words comprised 1.35 percent of words used (2.47). Discrepancy-related words comprised 1.66 percent (2.82) of words used. Tentativeness-related words comprised 4.20 percent (4.62) of the words used. Certainty-related words comprised 1.29 percent (2.40) of words used. Difference-related words comprised 2.72 percent (3.05) of words used.

3.3.1 Hypothesis 1: Manipulation Checks. The first set of manipulation checks examining self-reported affect as a function of reappraisal indicated that participants exhibited some of the expected changes in self-reported affect as a result of the emotion regulation task. Reappraisals appeared to be partially effective on a subjective level, as evidenced by the fact that Likert scores of self-reported positive affective ratings increased significantly as a function of reappraisal ($t(22) = -5.78$; $p < .001$; $d = 1.22$). The average change in positive affect from pre-reappraisal to post-reappraisal was 1.39 (1.15) points. There was no significant reduction in self-reported negative affect as a function of verbal reappraisals ($t(22) = 1.75$; p =.10; d = -.37). The average change in negative affect from pre-reappraisal to post-reappraisal was -1.72 (4.01; of note, this standard deviation was inflated because while some participants reported a reduction in self-reported negative affect as a function of the reappraisal task, other participants either reported no changes in self-reported affect or experienced an increase in negative affect). See Figure 4 for a visual depiction of the change in positive and negative affect as a function of reappraisal.

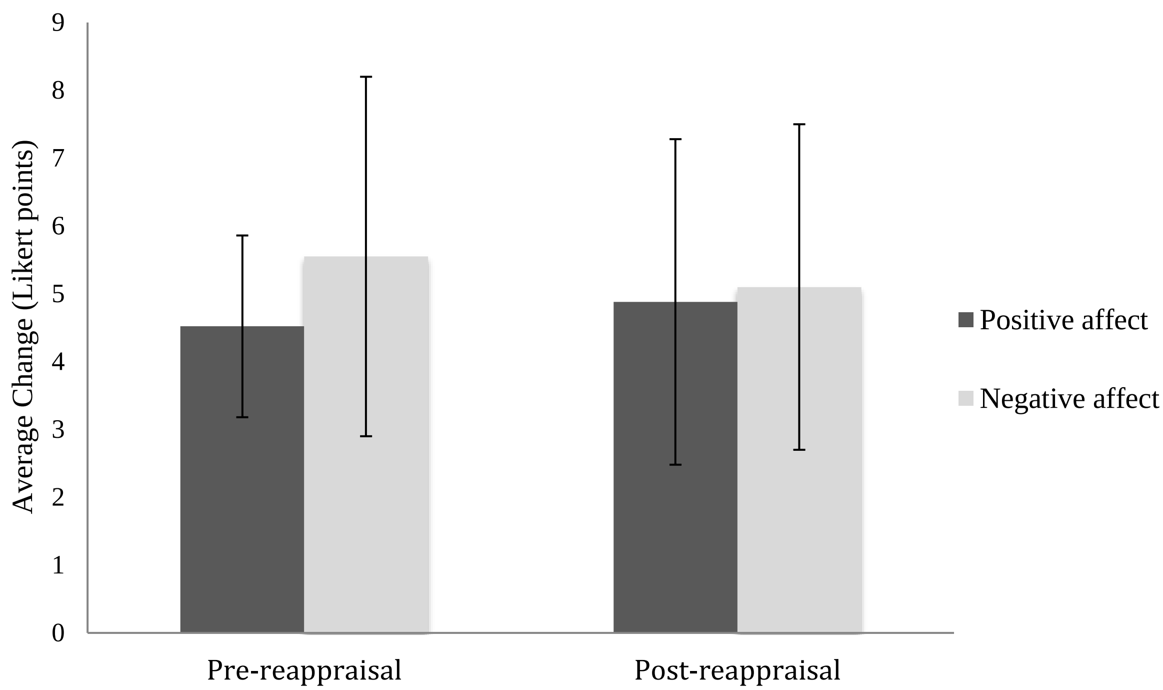

Figure 4. Mean change in self-reported affect as a function of reappraisal (error bars represent standard deviations). There was a significant change in positive affect from pre- to post-reappraisal (d = 1.22), whereas the change in negative affect from pre- to post-reappraisal was not significant (d = -.37). Note the variability of responses in pre- and post-reappraisal reports of positive and negative affect (SD pos pre- = 1.34. SD pos post- = 2.4. SD neg pre- = 2.65 SD neg post- = 2.4).

The second set of manipulation checks examining lexical and self-reported indices of emotion regulation indicated that, as hypothesized, lexical measures were significantly related to self-reported affect. Interestingly, both positive ($r(21) = -.58$; p = .006) and negative ($r(21)$ = -

.49; p = .02) emotion word use during verbal reappraisal were significantly negatively correlated with the change in self-reported negative affect. Neither positive (r(21) = -.13; p = .58) nor negative (r(21) = .18; p = .44) emotion word use was significantly correlated with change in self-reported positive affect. Cognitive process word use was not significantly correlated change in self-reported positive (r(21) = -.05; p = .83) or negative affect (r(21) = -.11; p = .65).

The third set of manipulations checks examining the relationship between eye-tracking measures and the lexical indices of emotion regulation and self-reported change in affect indicated there was a significant positive correlation between self-reported positive affect prior to the reappraisal and the duration of gaze on positive stimuli (r(21) = .41; p = .05). There was also a significant positive relationship between the duration of gaze on positive stimuli and the change in negative affect (r(21) = .44; p = .04). Our eye-tracking measure of attentional bias was not significantly correlated with self-reported or lexical indices of emotion regulation (p's > .05). Cognitive control was non-significantly positively correlated with ERQ reappraisal (r(21) = .29; p = .17) and negatively correlated with ERQ distraction (r(21) = .-28; p = .19), with the direction of these correlations reflecting the hypothesized cognitive resources required for these respective emotion regulation strategies. The correlations discussed above and the rest of the correlations conducted as preliminary analyses are provided in Table 2.

3.4 Lexical Indices of Emotion Regulation

3.4.1 Hypothesis 2a: Eye-tracking measure of attentional deployment and lexical indices of reappraisal. In the first step of the mediation model (path c'), our results indicated that attentional deployment was not a significant predictor of cognitive mechanism word use (c' = -.67, SE = .53; p = .22; c'_{cs} = -.31). Attentional deployment was not a significant predictor of affective word use (c' = -.15, SE = 1.65; p = .93; c'_{cs} = -.02). In probing this relationship as a function of emotional valence, attentional deployment was not a significant predictor of positive word use (c' = .19, SE = 1.49; p = .89; c'_{cs} = .03) or negative word use (c' = -.37, SE = .66; p = .58; c'_{cs} = -.13).

3.4.2 Hypothesis 3a: Eye-tracking measure of attentional deployment and cognitive control. The second regression analysis in the mediation analysis (path *a*) indicated that attentional deployment was not a significant predictor of cognitive control performance (a = .92, SE = .75; p = .23). Because the relationship between our measure of attentional deployment and cognitive control was examined across each model, the results remained the same across analyses for each of the models examining lexical analyses as outcomes.

Table 2. Correlations between measures of emotional experience, expression, and regulation

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1. Pos rating (pre-)	–	.88**	-.07	-.41*	-.39†	.81**	-.34	-.21	-.06	.21	.41*	-.25	.35	.18	.14	-.06	.34	.28
2. Pos rating (post-)		–	.39†	-.28	-.39†	.75**	-.40	-.16	-.05	.11	.24	-.07	.27	.26	.24	-.04	.26	.30
3. Pos affect change			–	.21	-.04	-.01	-.13	.17	-.05	-.19	-.29	.32	-.04	.13	.13	.08	-.05	.10
4. Neg rating (pre-)				–	.88**	-.76**	.44*	.23	.24	-.17	-.30	.13	-.29	-.52*	-.16	-.04	-.47*	.01
5. Neg rating (post-)					–	-.84**	.50*	.40	.20	-.28	-.34	-.003	-.08	-.64**	-.15	-.04	-.45†	.07
6. Neg affect change						–	-.50*	-.39	-.08	.27	.44*	.19	.22	-.50*	.16	-.06	.53*	.08
7. % Pos words							–	.08	.41	-.20	-.37	.06	-.01	-.21	-.25	-.42	-.39	.10
8. % Neg words								–	-.12	-.31	-.30	-.08	.35	-.19	.13	.07	-.005	.16
9. % Cog mech words									–	-.16	-.08	-.37	-.08	-.01	-.39	-.46	-.26	-.34
10. Visit duration Neg										–	.87**	-.29	.05	.11	-.44	-.13	-.19	.14
11. Visit duration Pos											–	-.10	.06	.07	-.25	-.25	-.04	.04
12. Attentional deploy												–	-.19	.12	-.19	.13	-.22	.23
13. ERQ Reappraisal													–	.23	-.14	.01	.28	.29
14. ERQ Distraction														–	-.11	-.12	.41	-.28
15. Pos rate pos stim															–	.27	.63**	.29
16. Neg rate neg stim																–	-.76**	.38
17. Intensity rating																	–	-.06
18. AX-CPT d’																		–

* $p < .05$
** $p < .01$
† $p = 0.06$

3.4.3 Hypothesis 4a: Cognitive control and reappraisal. The third regression analysis indicated that cognitive control was not a significant predictor of cognitive mechanism word use (b = -.67, SE = .53; p = .22). Similarly, cognitive control was not a significant predictor of affective word use (b = .35, SE = .48; p = .47). This pattern of findings held for positive (b = .17, SE = .43; p = .69) and negative (b = .15, SE = .19; p = .42) word use, respectively.

3.4.4 Hypothesis 5a: Mediating effect of cognitive control on attentional deployment and reappraisal. The mediating effect of cognitive control on the relationship between attentional deployment and reappraisal was not significant when predicting cognitive mechanism word use (ab = -.57; SE = .59; CI = -1.56 to .93; ab_{cs} = -.06), affective word use (ab = .32; SE = .56; CI = -.74 to 1.54; ab_{cs} = .05), positive (ab = .16; SE = .42; CI = -.75 to .96; ab_{cs} = .03), or negative (ab = .14; SE = .23; CI = -.22 to .70; ab_{cs} = .05) word use.

3.5 Change in Subjective Emotional Experience

3.5.1 Hypothesis 2b: Eye-tracking measure of attentional deployment and self-reported emotional experience. The first regression in the mediation analysis indicated that attentional deployment was not a significant predictor of change in self-reported positive affect (c' = .92, SE = .63; p = .16; c'_{cs} = .31).

3.5.2 Hypothesis 3b: Eye-tracking measure of attentional deployment and cognitive control. The second regression in the mediation analysis indicated that attentional deployment was not a significant predictor of cognitive control performance (a = .83, SE = .78; p = .30).

3.5.3 Hypothesis 4b: Cognitive control and self-reported emotional experience. The third regression in the mediation analyses indicated that cognitive control was not a significant predictor of change in self-reported positive affect (b = .02, SE = .17; p = .91).

3.5.4 Hypothesis 5b: Mediating effect of cognitive control on self-reported emotional experience. The mediating effect of cognitive control on the relationship between attentional deployment and reappraisal was not significant when predicting change in self-reported positive affect (*ab* = .02; SE = .18; CI = -.39 to .34; ab_{cs} = .006).

3.6 Comparing Models

The results of the analyses comparing the relative standardized weight of attentional deployment (β for path *c'*) on the lexical and self-reported measures of emotion regulation indicated that lexical and self-reported indices of emotion regulation were approximately equivalent outcome variables, with no variable being significantly more related to attentional bias than the next. The relationship between attentional deployment and cognitive mechanism word use was not significant (β for path *c'* = -.76; SE = .52; *p* = .16). The relationship between affective word use was not significant (β for path *c'* = -.05; SE = .55 *p* = .93). Examining these relationships as a function of emotional valence, nether the relationship between attentional deployment and positive word use (β for path *c'* = .08; SE = .59 *p* = .90) nor negative word use (β for path *c'* = -.30; SE = .54 *p* = .58) was significant. Attentional deployment was not a significant predictor of change in self-reported positive (β for path *c'* = .81; SE = .56; *p* = .16) or negative (β for path *c'* = -.57; SE = .58 *p* = .33) affect. The results of the z-tests examining the relative difference between weights for each of these respective models are provided in Table 3.

Table 3. Tests of Significance for Select Predictors

	Z Score	*p* value
Positive LIWC vs. Δ Positive Affect	-.13	.89
Cog Mechanism LIWC vs. Δ Positive Affect	1.07	.28
Affect LIWC vs. Δ Positive Affect	-1.09	.27
Δ Positive Affect vs. Δ Negative Affect	-1.11	.27

3.7 Post-hoc Moderated Mediation Analyses Examining Stimulus Intensity

Participants' orthogonal self-reported ratings of positive and negative valence of the stimuli, indicated that the negative images were not significantly more intense than positive stimuli ($t(22) = -.34$; $p = .73$; $d = .08$). When rated without the influence of the matched negative image, positive images were rated with a mean affective intensity of 6.28 (2.08) and negative images were rated with a mean affective intensity of 6.53 (2.50). The average composite stimulus intensity score was -.26 (3.22), confirming that overall, participants rated negative stimuli as non-significantly more intense than positive stimuli. When rated without the influence of the matched positive image, negative stimuli were rated as significantly more negative than negative ratings of positive stimuli ($t(22) = 6.77$; $p < .001$; $d = 1.63$). Positive ratings of positive stimuli were rated as significantly more positive than positive ratings of negative stimuli ($t(22) = 6.85$; $p < .001$; $d = 1.60$). See Table 4 for mean affective and intensity ratings of all stimuli.

Table 4. Self-report orthogonal affective responses

Positive Rating of Positive Images	6.28 (2.08)
Negative Rating of Positive Images	3.08 (1.50)
Stimulus Intensity Composite	-.26 (3.22)
Positive Rating of Negative Images	3.32 (2.49)
Negative Rating of Negative Images	6.53 (2.50)

3.7.1 Post hoc hypothesis 2: Eye-tracking measure of attentional deployment and reappraisal. As in the above simple mediation analyses, the results of the first step of the moderated mediation analyses (path *c'*) indicated that attentional deployment was not a significant predictor of cognitive mechanism word use ($c' = .91$, SE = 2.98; $p = .76$) or affective word use ($c' = -2.21$, SE = 1.68; $p = .21$). In probing this relationship as a function of emotional valence, attentional deployment was not a significant predictor of positive word use ($c' = -1.05$, SE = 1.44; $p = .48$) or negative word use ($c' = -1.27$, SE = .97; $p = .21$). As above, attentional deployment was not a significant predictor of change in self-reported positive affect (c' = -.23, SE = .99; p = .82).

3.7.2 Post hoc hypothesis 3: Eye-tracking measure of attentional deployment and cognitive control. As in the simple mediation analyses, attentional deployment was not a significant predictor of cognitive control performance (a = 1.23, SE = 1.16; p = .31). Because this relationship was examined across each moderated mediation model and did not vary across models, the results remained the same across analyses for each of the models examined here.

3.7.3 Post hoc hypothesis 4: Cognitive control and reappraisal. As in the simple mediation analyses, cognitive control was not a significant predictor of cognitive mechanism word use (b_1 = -.72, SE = .56; p = .22) or affective word use (b_1 = .47, SE = .33; p = .18). This pattern of findings held for positive (b_1 = .30, SE = .29; p = .31) and negative (b_1 = .15, SE = .19; p = .75) word use, respectively. Cognitive control performance was also not a significant predictor of change in change in self-reported positive affect (b_1 = .001, SE = .19; p = .99).

3.7.4 Post hoc hypothesis 5: Moderating effect of stimulus intensity. Stimulus intensity was not a significant predictor of cognitive mechanism word use (b_2 = .43, SE = .35; p = .25). Stimulus intensity was also not a significant predictor of affective (b_2 = -.05, SE = 18; p = .79), positive (b_2 = .14, SE = .15; p = .38, or negative (b_2 = .09, SE = .10; p = .38) word use. Similarly, stimulus intensity was not a predictor of change in self-reported positive affect (b_2 = .006, SE = .10; p = .95).

Regarding the moderating effect of stimulus intensity on cognitive control, the interaction between cognitive control and stimulus intensity was not a significant predictor of cognitive mechanism word use (b_3 = .18, SE = .28; p = .52). This interaction also did not significantly predict affective word use (b_3 = .27, SE = .15; p = .10) or positive (b_3 = .11, SE = .13; p = .40) word use. This interaction was nearly significant when predicting negative word use (b_3 = .17, SE = .09; p = .08). The interaction was not a significant predictor of change in self-reported positive affect (b_3 = .05, SE = .09; p = .62).

3.7.5 Post hoc hypothesis 6: Mediating effect of cognitive control on attentional deployment and reappraisal. Taken together, the above analyses indicate that the mediation of the relationship between attentional deployment and cognitive mechanism word use is not significantly moderated by stimulus intensity (ab_3 = .20; CI -.45 to 1.48). Similarly, the mediating role of cognitive control was not significantly moderated by stimulus intensity in the relationship between attentional deployment and affective word use (ab_3 = .33; CI -.45 to .98). This pattern of findings held when examining positive (ab_3 = .14; CI -.48 to .49) and negative (ab_3 = .21; CI -.15 to .74) word use, respectively. The mediating role of cognitive control was not significantly moderated by stimulus intensity in the relationship between attentional deployment and change in self-reported positive affect (ab_3 = .05; CI -.22 to .40). Of note, while the confidence interval for ab_3 in the model predicting affective word use did include zero, suggesting a non-significant moderated mediation effect when predicting affective word use, the Johnson-Neyman probe indicated that for at least a portion of the sample, there was there was a significant moderated mediation relationship when predicting affective word use. See Figure 5 for a graphical representation of the conditional indirect effect.

In probing the moderated mediation for the model predicting affective word use, the Johnson-Neyman probe method revealed that the conditional indirect effect of cognitive control was significant for a group of participants who indicated that positive stimuli were relatively more intense than negative stimuli (27.8% of our sample reported that positive stimuli were at least 1.21 Likert points more intense than negative stimuli; p's $< .05$; Figure 5). The Johnson-

Neyman method also indicated that mediating role of cognitive control on affective word use was not significant for individuals who rated negative stimuli as more intense than positive stimuli (72.2% of our sample reported that negative stimuli fell within a range of as extreme as 5.27 Likert points more intense than positive stimuli to positive stimuli being only .82 Likert points more intense than negative stimuli; *p*'s .30 - .07). The Johnson-Neyman probe method did not indicate a significant mediating effect for any subset of the participants when predicting any other outcome variables.

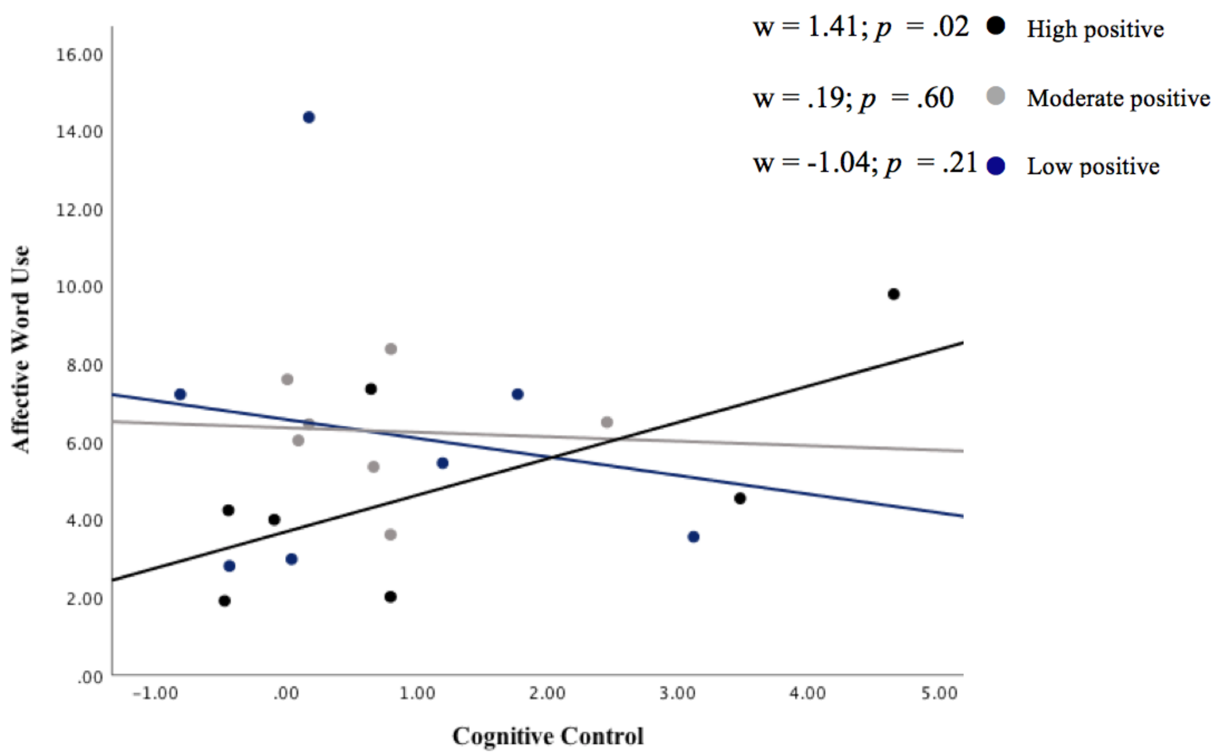

Figure 5. Affective word use, mediated by cognitive control, as a function of stimulus intensity. The slopes of each of these lines indicate the relative strength of the mediating role of cognitive control in the relationship between affective word use and cognitive control. One potential outlier was found in the low positive condition, though the mediating relationship was not significant for this group, suggesting that it did not unduly influence interpretation of these results.

3.8 Exploratory Analyses

3.8.1 Symptom severity and emotion regulation. Our exploratory analyses examined the relationships between clinician-rated symptoms and our various measures of emotion regulation. BPRS positive symptoms were significantly correlated with a number of indicators, including lower ratings of positive affect prior to ($r(22) = -.49$; $p = .02$) and after ($r(22) = -.42$; $p = .046$) reappraisals, as well as relatively smaller changes in self-reported affect as a result of reappraisal ($r(22) = -.44$; $p = .04$). BNSS alogia was significantly positively correlated with ERQ distraction ($r(22) = .45$; $p = .03$) and cognitive mechanism word use ($r(22) = .43$; $p = .048$). Finally, BPRS negative symptoms were significantly negatively correlated with affective word use ($r(22) = -.44$; $p = .04$) and positively correlated with cognitive mechanism word use ($r(22) = .43$; $p = .04$) in the reappraisals. No symptom domain was significantly correlated with cognitive control performance or with individual differences in ratings of stimulus intensity (p's $> .05$). Complete correlational analyses examining symptom domains and indices of emotion regulation can be found in Table 5.

Table 5. Correlations between clinician-rated symptoms and measures of emotion expression/regulation

	Attention deploy	Intensity	LIWC Affect	LIWC Cog Mech	LIWC Pos	LIWC Neg	Pos Change	Neg Change	Distraction	Reappraisal	AX-CPT d'
BNSS Anhedonia	.14	.35	-.23	.30	-.20	-.14	-.12	.15	.11	.03	.11
BNSS Asociality	.18	.07	-.11	.10	-.04	-.23	-.31	-.07	-.10	.01	-.07
BNSS Avolition	.14	.41	-.27	.37	-.20	-.27	-.17	-.07	.29	.13	-.18
BNSS Blunted Affect	-.12	.09	-.30	.40	-.17	-.39	-.20	.22	.28	-.31	-.37
BNSS Alogia	-.02	.27	-.21	.43*	-.12	-.28	-.16	.36	.45*	-.07	-.31
BPRS Positive	.19	-.04	.32	.02	.28	.20	.08	-.44*	.0003	.004	.04
BPRS Negative	.004	.23	-.45*	.48*	-.40	-.24	-.11	.14	.26	-.34	-.33
BPRS Activation	.17	.03	-.12	-.27	-.11	-.04	.20	-.08	-.23	-.29	-.08
BPRS Affect	.17	.08	0.16	-.23	.22	-.06	-.04	-.15	-.09	-.17	.03
BPRS Total	.20	.02	0.07	-.002	.10	-.01	.40	-.24	.006	-.23	-.10

* $p < .05$

CHAPTER 4. DISCUSSION

Individuals with schizophrenia exhibit abnormalities in emotion regulation, which may contribute to increased experience of negative affect (Cohen & Minor, 2010; Horan et al., 2013; Strauss et al., 2013). Despite this, few studies have examined the efficacy of emotion regulation strategies or the relationships between emotion regulation strategies in individuals with schizophrenia. Moreover, only one study has proposed neurocognitive mechanisms that may explain the abnormalities in these emotion regulation strategies in schizophrenia (Strauss et al., 2013). The current study sought to fill these gaps using a novel measure of emotion regulation to examine the relationship between attention deployment and reappraisal, and by examining the mediating role of cognitive control in this relationship. The primary findings indicated that cognitive control alone was not a significant mediator of the relationship between attentional allocation and reappraisal. However, as revealed by our post-hoc analyses, there was a partial mediating role of cognitive control for a select group of participants, which was moderated by individual differences in ratings of the intensity of emotional stimuli. Our findings suggest that during reappraisal, cognitive control may mediate the relationship between attentional deployment and reappraisal as measured by affective word use, as a function of differences in emotional reactivity. These findings, including implications for future research, treatment, and assessment of individuals with psychotic disorders, as well as limitations and opportunities for additional research, are discussed below.

4.1 Incorporating the Current Findings into the Extant Literature

4.1.1 The mediating role of cognitive control in emotion regulation. Cognitive control alone did not mediate the relationship between attentional deployment and lexical or self-reported indices of emotion regulation during verbal reappraisal. Prior studies have examined the relationship between attentional deployment and reappraisal in healthy controls (Bebko et al., 2011; Urry, 2010; van Reekum et al., 2007) and other studies have clarified the relative importance of cognitive control on attentional deployment (Strauss et al., 2013) and reappraisal (Strauss et al., 2014) in individuals with schizophrenia, but this study expanded upon these studies in a sample of participants with schizophrenia by applying Gross's (1998) process model of emotion regulation to clarify the potential mediating role of cognitive control in the relationship between attentional deployment and reappraisal. Our non-significant results regarding this relationship are somewhat surprising given the theoretical importance of the relationships between each of the variables in the model. Examining the component analyses of the primary mediation analyses indicated that no single component of the mediation analyses was alone significant. However, compare these findings to the significant partial mediating role of cognitive control, which was moderated by individual differences in ratings of stimulus intensity found in the post-hoc analyses.

While the mediating role of cognitive control alone was not significant, it was a significant mediator for a portion of participants when moderating for individual differences in ratings of stimulus intensity. For a portion of our sample (27.8%) who self-reported positive stimuli as more intense than negative stimuli, cognitive control was a significant mediator between attentional deployment and reappraisal, as measured by affective word use. Our findings suggest that for this subset of participants, these strategies operate in a partially synergistic fashion, with lower order processes like attention deployment contributing to higher order processes like reappraisal, and cognitive control mediating this relationship. Individuals with schizophrenia as a group are more prone to overutilize less effective emotion regulation strategies than controls (Perry, Henry, & Grisham, 2011), suggesting that group differences may account for this relationship when comparing individuals with schizophrenia to controls. While the current study did not include a control group, studies examining ratings of valence and intensity of positive and negative stimuli indicate generally that individuals with schizophrenia do not differ from controls in their ratings of intensity (Flemming & Potkin, 2003), suggesting that diagnostic- or symptom-related concerns did not account for the discrepancy in the strength of this relationship in the current study. However, other studies indicate that within-group differences may contribute to the discrepancy in the strength of these relationships. For example, individuals with extreme negative symptoms exhibit a pattern of increased negative arousal when viewing normed negative stimuli as compared to controls and to individuals with schizophrenia with fewer negative symptoms (Strauss & Herbener, 2012). In the current study, participants who rated positive stimuli as more intense than negative stimuli did not differ from participants who rated negative stimuli as more intense than positive stimuli on demographic or clinical variables, including negative symptom ratings (p's > .05).

Emotional reactivity, as rated by individual differences in ratings of stimulus intensity, may represent one potential mechanism underlying the mediating role of cognitive control in the relationship between attentional deployment and reappraisal. Emotional reactivity is a component of trait negative affect, described as the threshold for eliciting a response given a stimulus of a specified intensity (Davidson, 1998). Emotional reactivity is associated with increased severity of symptoms in individuals with psychosis (Myin-Germins, van Os, Schwartz, Stone, & Delespaul, 2001). It also has implications for emotion regulation. Cavanagh, Fitsgerald, and Urry (2014) found that emotional reactivity was a mediator of cognitive reappraisal effectiveness, with lower reactivity prompting greater effectiveness of reappraisal. Additionally, Sheppes and colleagues (2012) found that the intensity of a given situation influences the emotion regulation strategy used, with less cognitively taxing strategies like distraction being used in higher-intensity situations. Individual differences in emotional reactivity may therefore lead to discrepancies in emotion regulation effectiveness and strategy choice, potentially causing discrepancies in the interactions between these strategies towards effective emotion regulation. While no research has examined emotion regulation choice as a function of emotional reactivity, it is conceivable that individuals with increased emotional reactivity may be more likely to become overwhelmed and default to less cognitively taxing emotion regulation strategies, leading to less effective emotion regulation. Given that emotionally valenced stimuli have been shown to reduce cognitive capacity (Cohen, Henik, & Moyal, 2012), the relationship between emotion regulation strategies and cognitive control may become exhausted in individuals who are overwhelmed by emotionally valenced stimuli. Emotional reactivity may also be dose-dependent, such that individual differences in emotional reactivity may be related to higher chronicity of symptoms or longer periods of illness. Genetic studies point to the Serotonin Transporter Gene (5-HTTLPR), which has been implicated in schizophrenia (Hranilovic et al., 2000), as a component of emotional reactivity and cognitive control (Stollstorff et al., 2013). Future research may clarify this relationship by stratifying as a function of emotional reactivity.

4.1.2 Attentional deployment and reappraisal. Attentional deployment alone was not a significant predictor of lexical or self-reported indices of emotion regulation. These findings are somewhat in contrast to Monin and colleagues' (2009) work, which found that both affective and cognitive mechanism word use were both predictors of cardiovascular reactivity. Our results indicate that lexical indices of emotion regulation do not confer particular advantage over self-reported indices of emotion regulation. Importantly though, change in self-reported affect was not significantly predicted by our measure of attentional deployment, underscoring the difficulty in measurement of emotion regulation effectiveness and to a greater extent, the relationships between higher- and lower-order emotion regulation strategies. The current findings provide similar conclusions about the relationship between reappraisal and attentional deployment to Urry’s (2010), who found that reappraisal effectiveness varied independently of attentional deployment. The results of the analyses examining attentional deployment and reappraisal, as well as the moderated mediation analyses discussed above, contribute to our understanding of the processes model of emotion regulation, which posits that lower order emotion regulation strategies like attentional deployment influence higher order strategies like reappraisal (Gross, 1998a). However, the non-significant relationship between attentional deployment and reappraisal in the current study indicates that this relationship is not straightforward.

Our non-significant findings examining the relationship between attentional deployment and reappraisal might be explained by the time course of emotion regulation strategy use and measurement of emotion regulation, respectively. One explanation for the non-significant relationship between attentional deployment and our indices of reappraisal might include a mismatch in the temporal dynamics of emotion regulation strategy use. While attentional deployment and reappraisal are both antecedent strategies, attentional deployment focuses on aspects of the situation to attend to and reappraisal focuses on the meaning of the situation (Gross, 1998b), indicating that these strategies focus on discrete facets of an emotionally evocative stimulus, and that they may be employed across differing time courses following emotion generation. In support of these temporal differences, John and Gross (2004) posited that emotion regulation strategies are related as a function of time, with distinct emotion regulation strategies being appropriately utilized across the temporal stream of emotion generation. Sheppes and Gross (2011) have also posited that the amount of time between emotion generation and the deployment of a given regulation strategy may be more useful in predicting the usage and effectiveness of emotion regulation strategies than individual differences or preferences in strategy use. Our emotion regulation task required the simultaneous use of reappraisal and attentional deployment despite the fact that these strategies are likely best employed most effectively on slightly different time courses. Another temporal consideration includes the time course by which the outcome variables used in each of these studies operate. Van Reekum and colleagues (2007) utilized amygdala activity as their outcome variable, whereas Bebko and colleagues (2011) utilized self-reported emotional experience from the ERQ. The relationship between attentional deployment and ERQ reappraisal was examined in exploratory analyses, with the results mirroring Bebko and colleagues' (2011) findings that attentional deployment was not related to ERQ scores. Bebko and colleagues (2011) point out that measures of emotion regulation may vary as a function of time course. Amygdala activity, for example, has been shown to diminish prior to reductions in self-reported changes in emotional experience are even perceived (Diano, Celeghin, Bagnis, & Tamietto, 2016), suggesting that the units of measure across these studies are not temporally consistent. Taken together, these findings highlight the importance of clarifying the units of measurement for indices of emotion regulation and the time course in which each of these indices are expected to take place when parsing the relationships between them. Further research is required to address whether addressing these temporal discrepancies clarifies the relationship between attentional deployment and reappraisal.

Despite the potential discrepancies in timing, there are several proposed common factors underlying emotion regulation strategy use that might contribute to our understanding of the non-significant relationship between attentional deployment and reappraisal. One recent study found that the variables influencing emotion regulation strategy use included intra- and inter-individual differences in cognitive resources (i.e., attention, working memory, executive control) required for emotion regulation; the level of engagement/disengagement that regulation is likely to provide; and intra-individual differences in responses to emotional intensity related to the specific emotion regulation strategy used in a given situation (Sheppes, Scheibe, Suri, & Gross, 2011). There is reason to believe that the relationship between emotion regulation strategies might differ in individuals with schizophrenia as compared to controls. Given the documented cognitive deficits in attention (Bozikas et al., 2005), working memory (Barch et al., 2009), and executive control (Lesh et al., 2011), as well as the propensity for individuals with schizophrenia to overutilize distraction and underutilize reappraisal (Perry et al., 2011), it might be the case that emotion regulation strategies are used differently and are implemented by different mechanisms than healthy controls. Van der Meer and colleagues (2009) point out that individuals with schizophrenia utilize a different set of emotion regulation strategies than controls. They point to a set of skills that they name "cognitive-emotionalizing", which includes identifying, verbalizing, and analyzing emotions, as one potential domain leading to discrepancies in emotion regulation strategy use. While the current study sought to clarify the relationships between these strategies and the variables influencing emotion regulation in individuals with schizophrenia, clarifying the relationships between these strategies in healthy controls would provide a useful basis of comparison for individuals with schizophrenia.

4.1.3 Attentional deployment and cognitive control. Regarding the third hypothesis, attentional deployment alone did not significantly predict cognitive control. These findings may not be surprising given the fact that cognitive control is a superordinate domain, with several cognitive processes, including attention (Posner & Snyder, 2004) all existing partially in support of it. One theory of cognitive control posits that attentional resources may work to facilitate goal-directed behavior and filter irrelevant information (Mackie, Van Dam, & Fan, 2013), acting as a perceptual selection mechanism, which serves to reduce distracting perceptual information that exhaust perceptual capacity in processing relevant stimuli. Cognitive control then acts to reduce interference from perceived distractors in order to maintain current priorities (Lavie, Hirst, de Fockert, & Viding, 2004). Attentional deployment may therefore be viewed as one discrete component in the symphony of cognitive control mechanisms, which has been hypothesized to serve towards emotion regulation (Buschman & Miller, 2007). Given the hierarchical relationship between cognitive control and attentional deployment, the above analysis was reversed in order to examine the mediating role of attentional deployment in the relationship between cognitive control and reappraisal. However, these analyses yielded non-significant results similar to the initial analyses, indicating that cognitive control did not significantly predict attentional deployment. Additionally, despite the theoretical basis of the structure of cognitive systems underlying the reversal of attentional deployment and cognitive control, this reversal did not fit into the process model of emotion regulation (Gross, 1998a).

Our non-significant findings between attentional deployment and cognitive control were in line with the literature, indicating that general measures of cognitive control are unrelated to attentional deployment in emotion regulation in individuals with schizophrenia (Strauss et al., 2014). Strauss and colleagues did not find a significant relationship between performance on the Dot Probe task, a measure of cognitive control, and LPP amplitude during a task of guided attentional deployment. However, the authors point to a reduced number of fixations across both negative and neutral areas of interest as evidence of abnormalities in cognitive control. This lack of association, coupled with Strauss and colleagues (2014) pattern of eye-tracking findings, might suggest that cognitive control is either dynamic and is therefore related to reappraisal temporally or that tasks explicitly examining cognitive control performance like the Dot Probe task used by Strauss and colleagues (2014) do not fully reflect the abnormalities that would be expected to be associated with abnormalities in attentional deployment. Of note, in this study visual attention was constrained as an experimental manipulation. Because the current paradigm did not guide the attention of our participants towards any particular aspect of the visual scene, as was the case in Strauss and colleagues (2014), our findings do not allow for interpretation of gaze patterns based upon instruction, which might provide additional evidence of abnormalities in cognitive control. Taken together along with the above findings, these results indicate that while cognitive control may be important for some processes underlying emotion regulation, it does not predict attentional deployment alone. Instead, our findings indicate that for some participants cognitive control may serve as an orchestrating mechanism, which mediates the relationship between lower- and higher-order emotion regulation mechanisms.

4.1.4 Cognitive control and reappraisal. Regarding the fourth hypothesis, cognitive control alone was not a significant predictor of lexical or self-reported measures of reappraisal. This is partially in line with Strauss and colleagues (2013), who found Dot Probe performance was not related to LPP amplitude during a reappraisal task. These findings are somewhat surprising, given the results of McRae, Misa, and colleagues (2012), who found that the effectiveness of reappraisal strategies was related positively to several components of cognitive control including working memory capacity, set-shifting performance, and response inhibition. Cohen, Henik, & Moyal (2012) found that individual differences in reappraisal are related to efficiency of executive control. However, the current study examined goal maintenance, a discrete component of cognitive control, suggesting that our measure of cognitive control may have been too narrow or did not include one of the many facets of cognitive control that may be important in predicting reappraisal. Additional components of cognitive control may be useful to explore in our understanding of emotion regulation. Conceptually, goal maintenance is an important component in this relationship. However, cognitive control is a complex construct composed of several mechanisms that may be related to reappraisal. For example, verbal working memory, set shifting, response inhibition, and response selection have been implicated as important components of cognitive control (Lenartowicz, Kalar, Congdon, & Poldrack, 2010), which may also be valuable components in the relationship between attentional deployment and reappraisal.

Alternative explanations for the non-significant relationship between cognitive control and measures of emotion regulation in individuals with schizophrenia lie in the sequencing of cognitive processes required for emotion regulation and the sequence in which cognitive control was elicited with respect to reappraisal in the current study. Relatively little research has explored the predictive relationship of cognitive control on emotion regulation; however a recent study reversed this relationship to examine the role of emotion regulation on cognitive control (Sullivan & Strauss, 2017). These researchers found that cognitive control was not positively influenced by reappraisal in individuals with schizophrenia, but controls exhibited enhanced performance on a cognitive control task as a result of reappraisal. They point out the sequence required for accurate reappraisal as one potential mechanism underlying this abnormality in individuals with schizophrenia. Effective emotion regulation requires allocation of attention toward features of a stimulus that is being appraised and gating that information into working memory, followed by inhibition of initial pre-potent appraisals of the stimulus and selection of a goal-appropriate reappraisal. Finally, conflict-monitoring processes are engaged to determine whether the reappraisal attempted was effective at changing emotional response as intended

(Sullivan & Strauss, 2017). Regarding sequencing of cognitive control and emotion regulation more broadly, Cohen and Mor (2017) found that when reappraisal directly followed cognitive control tasks, reappraisal was more effective than when cognitive control was not elicited, suggesting that manipulations in cognitive control use may facilitate more effective emotion regulation in healthy controls. In the current study, the AX-CPT followed the reappraisal task rather than reappraisal directly following the task of cognitive control. Cohen and Mor's (2017) findings suggest that alterations in sequence of cognitive control and reappraisal may have reduced the strength of this relationship. Further assessment of the range of mechanisms underlying emotion regulation and the sequence in which cognitive control is elicited may clarify the effectiveness of sequencing of these tasks during laboratory assessments and would distinguish difficulties in sequencing from general deficits in any of these discrete mechanisms.

While cognitive control did not independently predict lexical or self-reported indices of emotion regulation, the interaction between cognitive control and individual differences in self-reported ratings of stimulus intensity (b_3) nearly significantly predicted both affective and negative word use during reappraisal. These findings are consistent with studies indicating that emotionally valenced stimuli have a differential effect on individuals with schizophrenia in a range of cognitive domains with respect to goal-directed behavior, including working memory (Becerril & Barch, 2011) and episodic memory (Matthews & Barch, 2010). Variations in emotional valence may influence cognitive control capacity (Cohen et al., 2016), which may in turn influence its strength of the relationship with reappraisal in individuals with schizophrenia. Comparing within our sample, the relationship between cognitive control and affective word use was only significant in a subset of participants who found positive stimuli relatively more intense than negative stimuli. This relationship did not hold in individuals who rated negative stimuli as more intense than positive stimuli, providing further support for findings suggesting that individuals with higher trait negative affect or emotional reactivity have difficulty controlling attention and inhibiting task-irrelevant information as a result of competition between goal-irrelevant and goal-relevant negative affect utilized for cognitive control (Inzlicht, Bartholow, & Hirsh, 2015). Pessoa (2009) provides another account of how trait negative affect may influence cognitive control. He posits that bottom-up stimulus-related factors and top-down states might both influence the flow of information through discrete cognitive control processes in the service of emotion regulation, leading to "executive competition" at each level of cognitive control. Individuals with schizophrenia exhibit abnormalities related to bottom-up emotional salience (Park, Park, Chun, Kim, & Kim, 2008) and top-down affective states (Strauss, Llerena, & Gold, 2011), suggesting that cognitive control in individuals with schizophrenia may be particularly sensitive to the effects of emotional reactivity.

4.1.5 Self-reported emotion regulation and biobehavioral measures. In addition to the primary findings, a number of findings regarding the relationship between biobehavioral and self-reported emotion regulation are of mention. ERQ scores were not significantly correlated with the eye-tracking measure of attentional deployment. This is somewhat surprising in light of Strauss, Ossenfort, and Whearty's (2016) findings that increased dwell time on emotionally salient stimuli, particularly early in the stimulus presentation, was associated with successful reappraisal over distraction. These results lend support to the hypothesis that these strategies are best employed across distinct time courses, and that the relationships between these strategies may be more strongly associated as a function of time than when examining their relationship without respect to time. Other studies have found significant relationships between other biobehavioral indicators of emotion regulation (i.e., LPP modulation; Horan et al., 2013) and self-reported ERQ reappraisal. However, LPP is considered a fairly direct measure of emotion regulation effectiveness with good internal consistency (Moran et al., 2013), suggesting that this measure may be more strongly related or a more "upstream" measure of emotion regulation than gaze duration, which has been shown to be a valid measure of visual attention (van den Bosch, 1984), but may reflect top-down and bottom-up influences and may exhibit weaker internal consistency when used in this capacity. Given the interplay between top-down and bottom-up influence, the relationship between self-reported emotion regulation and our eye-tracking measure of attentional deployment might expected to be only modestly correlated, as attentional deployment was not hypothesized as the only direct indicator of reappraisal, but as one of many downstream mechanisms (e.g., non-visual attention; Posner, 1980).

A second notable finding regarding biobehavioral and self-reported indices of emotion regulation indicated that ERQ scores were not significantly related to verbal reappraisal content or self-reported change in affect, which suggests potential discrepancies between the underlying systems associated with self-reported emotion regulation strategy use and our lexical and self-reported indices of emotion regulation. One potential explanation for these findings may be that there is a true dissociation between the various methods of assessment of emotion regulation strategies or within the memory systems underlying responses in individuals with schizophrenia. Across a range of affective domains, self-report information and actual behavior have been shown to activate discrete memory systems, leading to discrepancies in outcomes. Excluding laboratory assessments, emotion regulation is largely automatic and may be considered a component of procedural memory (Mauss, Bunge, & Gross, 2007). The memory systems utilized in self-report, however, can introduce additional measurement error, as they generally vary as a function of proximity with semantic information being activated when participants are asked to recall general or "typical" behavior and episodic information being activated when participants are asked to recall temporally proximal behavior (Robinson & Clore, 2002). This dissociation suggests that the memory systems utilized in completing the ERQ may have differed from those used during verbal reappraisal, leading to discrepancies in self-reported and actual emotion regulation. A final explanation involves the pattern of responses on the ERQ in our sample. The relationship between ERQ subscales was somewhat stronger than in samples consisting of healthy controls (e.g., Balzarati, John, & Gros, 2010; Gros & John, 2003 find negligible to small associations at best, whereas the correlation between these in our sample was small to medium). Studies examining these processes in individuals with schizophrenia have not directly provided information regarding the strength of the relationship between reappraisal and expressive suppression. This non-significant difference in the strength of associations as compared to controls might indicate that the underlying mechanisms for each strategy may be structured somewhat differently in individuals with schizophrenia than in healthy controls.

4.2 Implications for Treatment and Assessment

The results of the current study hold implications for treatment and assessment of individuals with psychotic disorders. Cognitive remediation has been shown to significantly decrease symptoms affecting social and emotional functioning in individuals with schizophrenia (Roder, Mueller, & Schmidt, 2011). Cognitive training techniques like cognitive remediation may represent one particularly effective treatment tailored to shaping implicit and explicit cognitive strategies associated with emotion regulation. Several studies (i.e., Hodel & Brenner, 1997) indicate that individuals with schizophrenia benefit from training in emotion regulation. One such method of training, Emotional Management Training aims to increase emotion regulation in individuals with schizophrenia by focusing on behaviors aimed at effective problem solving, verbal communication, and other explicit behaviors (Hodel, Kern, & Brenner, 2004). Attentional training is an effective treatment in reducing deficits associated with emotion regulation (Wadlinger & Isaacowitz, 2011). While no research has examined the use of these paradigms in individuals with schizophrenia, goal-directed attentional deployment was related to individual differences in emotion regulation as measured by self-reported frustration in a sample of anxious college students (Johnson, 2009). Finally, Sanchez, Everaert, & Koster (2016) found that manipulating attentional bias is effective in blind rated evaluations of verbal reappraisals, suggesting that if these strategies are used in the correct time course, visual attention may be malleable. Manipulation of visual attention and reappraisal may lead to improvements in emotion regulation. Future research may utilize these treatment techniques, combined with the knowledge of the mechanisms underlying the relationship between attentional deployment and reappraisal strategies of emotion regulation, to develop an intervention designed to treat abnormalities in emotion regulation in individuals with psychotic disorders.

Our findings have implications for affective science and clinical assessment. Several studies have sought to examine the habitual use of emotion regulation strategies in individuals with schizophrenia (Perry et al., 2011; van der Meer et al., 2009), as well as in healthy controls (Gross & John, 2003). Other studies have utilized expensive laboratory methodologies, including EEG and fMRI (Horan et al., 2013; Oschner, Bunge, Gross, & Gabrieli 2002) to examine specific mechanisms underlying emotion regulation. While these methodologies offer clear strengths, they lack ecological validity and do not take into account the dynamic interplay of emotion regulation strategies over time. Lexical analysis of reappraisal may offer an efficient methodology that may supplement or when appropriate, replace these existing assessments, and may further our understanding of the psychophysiological correlates of emotion regulation.

Furthermore, lexical analysis of reappraisals may be implemented as a widespread method of assessment in mobile (i.e., app based ecological assessment) and clinical settings.

4.3 Limitations and Opportunities for Future Research

The current study is not without limitations, which represent opportunities for future research. The first limitation to the current study is the sample size. While this sample is consistent with previous studies examining emotion regulation in individuals with schizophrenia (i.e., 25-31 participants with schizophrenia in Strauss et al., 2013 and Strauss et al., 2014), larger sample sizes have also been employed in studies examining emotion regulation in healthy controls (i.e., 54 participants in Urry, 2010). There are several alternatives to the convenience sampling methodology utilized in the current study. For example, Loughland and colleagues (2004) offer a method of screening a random sample or taking random participants from case registers. However, these methods are often costly, and require significant time and personnel to implement. Importantly, the sample in the current study was collected from several independent and assisted living facilities, and should be considered representative of individuals with schizophrenia across the spectrum of functioning. However, as measured by their performance on the AX-CPT, they may have exhibited somewhat lower cognitive control than other samples with schizophrenia, suggesting that this may have impacted their performance in some way.

Another potential limitation related to sampling was variation in diagnosis within our sample. Our sample consisted of 16 individuals diagnosed with schizophrenia, 6 individuals diagnosed with schizoaffective disorder, and 3 individuals diagnosed with psychotic mood disorders. Diagnostic variability is somewhat common within the schizophrenia literature. In particular, several prior studies examining affective abnormalities in schizophrenia have included individuals with schizoaffective disorder in their samples, suggesting that our understanding of cognitive and affective abnormalities can be generalized to individuals across the psychosis spectrum. In support of inclusion of these participants, the American Psychiatric Association reports scant evidence for distinct nosological categories between the two diagnoses (American Psychiatric Association, 2013). Studies examining emotional experience, expression, and regulation find similar patterns of deficit across individuals with schizophrenia and schizoaffective disorder (e.g., Oorschot et al., 2013). Moreover, several studies examining emotion regulation in schizophrenia have included individuals with any psychotic disorder in the patient group (Kimhy et al., 2012; O'Driscoll, Laing, & Mason, 2014), suggesting that our understanding of emotion regulation in schizophrenia reflects the psychosis spectrum rather than schizophrenia, proper. Finally, given the importance of dimensional frameworks like RDoC, diagnostic variability may be relatively unimportant when interpreting patterns of similar findings across diagnostic categories. In the current study, individuals did not differ in measures of objective or self-reported emotion regulation as a function of diagnosis. While a pure sample would be ideal in confirming these findings, our sample does not inhibit the generalizability of our findings.

4.4 Conclusions

The current study sought to examine the mediating role of cognitive control in the relationship between attentional deployment and reappraisal strategies of emotion regulation, utilizing a novel experimental paradigm and integrating biobehavioral measures of assessment. Our findings indicated that cognitive control alone was not a mediator in the relationship between attentional deployment and reappraisal when utilizing lexical or self-reported indices of emotion regulation. However, our post-hoc findings indicated that when accounting for the moderating role of individual differences in ratings of stimulus intensity, cognitive control significantly mediated the relationship between attentional deployment and reappraisal for part of our sample, as measured by affective word use. Emotional reactivity is proposed as one potential mechanism underlying this relationship. These findings provide evidence for potential cognitive and affective mechanisms underlying the relationships between emotion regulation strategies as explicated by the process model of emotion regulation.

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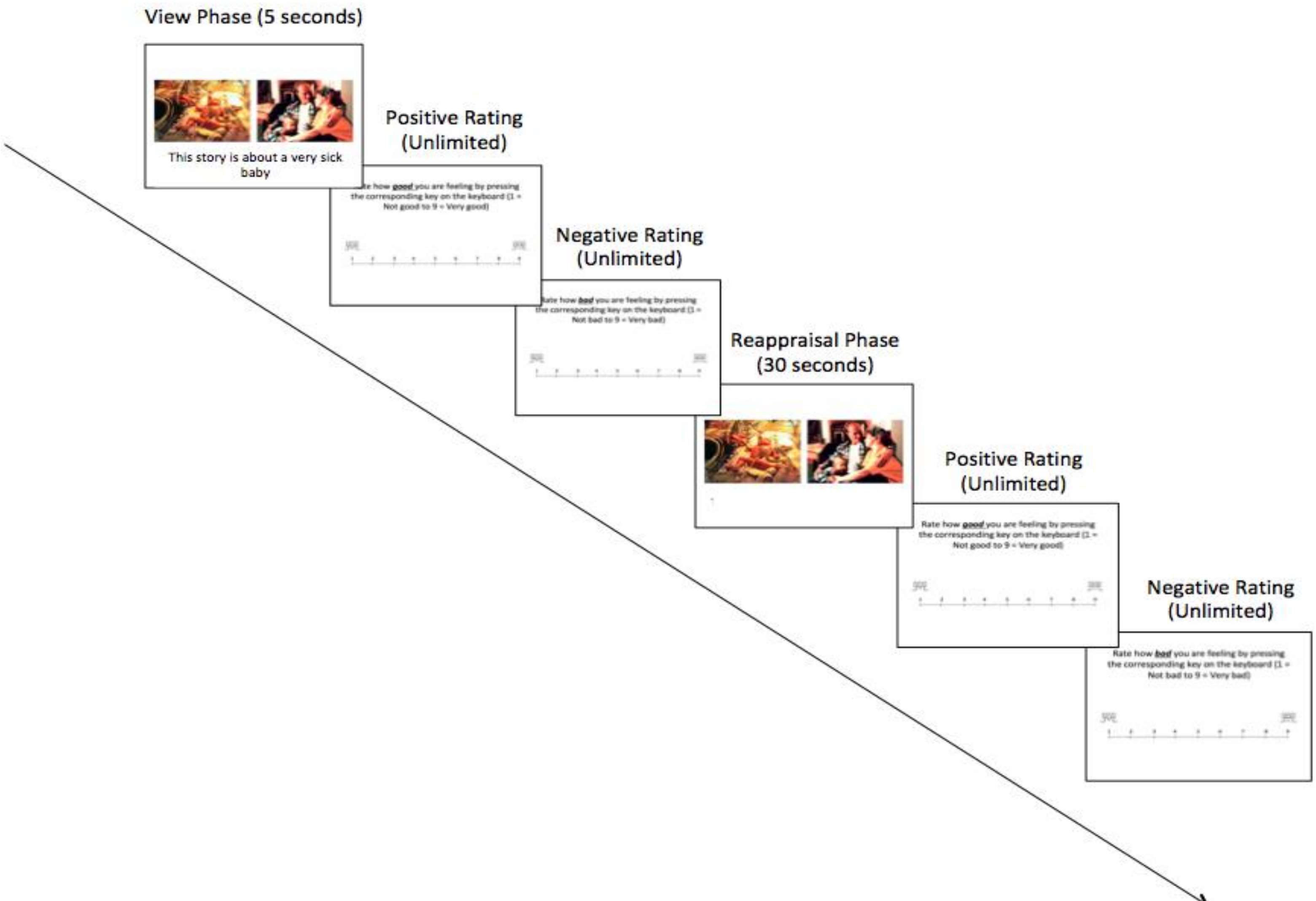
APPENDIX A. EMOTION REGULATION TASK STIMULI

A.1. List of stimuli prompts and images used in the emotion regulation task

Prompt	Negative Image	Positive Image
This story is about a dangerous shark attack	Sharks with blood in water	Man in lifeboat
This is a story about a baby who became very sick	Newborn attached to ventilator	Man, woman, and child embracing
This is a story about an innocent man who was mugged and shot on the subway.	Man holding gun to a man's head	Police officer holding a radio
This story is about an ecosystem that was badly polluted, causing lots of animals to be harmed.	Factory in distance, solid waste on ground	Group of people cleaning a beach
This is a story about a suicide bomber.	Person wearing hijab with explosives tied to body	Bomb squad disarming a bomb
This story is about an angry dog.	Close-up of dog with teeth exposed	Cat standing peacefully
This story is about an inhumane laboratory that makes medicine.	Rhesus monkey constrained with electrodes in brain	Young girl taking medication
This is a story about a family who became trapped in their home when it caught fire.	House on fire	Firemen operating hose
This is a story about people who were trapped on a plane when it caught fire.	Commercial airline on fire	Passengers escaping plane via emergency exit
This story is about a man who has become addicted to drugs and has lost almost everything.	Arm with needle injecting drugs in the street	Female doctor in lab coat providing treatment to man
This story is about a soldier who died in combat.	Woman kneeling and crying in front of a casket with an American flag affixed to it	New Orleans style funeral with people dancing
This is a story about a man who had his legs amputated.	Amputee sitting uncomfortably in bed	Amputee participating in a wheelchair race
This is a story about a child who is starving to death.	Emaciated child with ribs protruding	Aid workers providing food to young children

A.2. Schematic of stimuli for the emotion regulation task



APPENDIX B. EXAMPLE WORDS COUNTED BY LIWC PROGRAM

Cognitive Processes	Example words
Insight	think, know, consider
Causation	because, effect, hence
Discrepancy	should, would, could
Tentative	maybe, perhaps, guess
Certainty	always, never
Inhibition	block, constrain
Inclusive	with, and, include
Exclusive	but, except, without
Positive Affect	happy, pretty, good
Negative Affect	hate, worthless, enemy
Anxiety	nervous, afraid, tense
Anger	hate, kill, pissed
Sadness	grief, cry, sad

APPENDIX C. ADDITIONAL ANALYSES PREDICTING SELF-REPORTED CHANGE IN NEGATIVE AFFECT

Model	Unstandardized weight	S.E.	*p* value	Effect size
Simple Mediation				
Path *c'*	-2.25	2.25	.33	-.22
Path *a*	.83	.78	.30	–
Path *b*	.37	.62	.56	–
Path *ab*	.31	.46	–	.03
Moderated Mediation				
Path *c'*	-1.96	2.46	.44	–
Path *a*	.83	.78	.30	–
Path b_1	.41	.73	.58	–
Path b_2	-.08	.47	.87	–
Path b_3	-.15	.33	.66	–
Path ab_3	-.12	.46	–	–

APPENDIX D. IRB CONSENT FORM

Project Title: Emotion in adult stable outpatients

Performance Site:

1. Baton Rouge Mental Health Clinic, Baton Rouge, LA
2. Tyler Mental Health Clinic, Lafayette, LA
3. Louisiana State University, Baton Rouge, LA
4. Medical Management Options, Baton Rouge, LA
5. Subjects homes, as needed.

Investigator: The following investigators are available Monday-Friday, 9:00 a.m.- 4:30 p.m
Principal Investigator: Alex Cohen: (225) 578-7017
Co-investigator: Jessica McGovern: (225) 578-7017; jmcgov5@lsu.edu
Co-investigator: Kyle Mitchell: (225) 578-7017; kmitc33@lsu.edu

This is a consent form for research participation. It contains important information about this study and what to expect if you decide to participate. Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to participate.

Purpose of the Study: The purpose of this research project is to understand emotion (i.e., "feelings") in people with mental illnesses.

Inclusion Criteria: You are being asked to participate in this study because you are between the ages of 18 and 65, and are a patient with a mental illness diagnosis (e.g., schizophrenia or schizoaffective disorder) and are being treated by a mental health professional.

Exclusion Criteria: Participation is excluded for individuals who are a) not judged to be clinically stable; b) have any condition that interferes with visual sensitivity (e.g., glaucoma, cold); c) have a history of a neurological insult requiring overnight hospitalization; d) have estimated intelligence standard scores < 70; e) current or history of a severe substance use disorder; f) current daily cannabis use.

Maximum Number of Subjects: The maximum number of subjects will be 100.

Study Procedures/Description of the Study: This study will take place over the course of a single appointment lasting approximately two hours. During this session, I will be asked questions about my history and about my mental illness. I will also be asked to complete questionnaires and paper and pencil tests that measure current symptoms, attention, and depression. During parts of this session, I will complete computerized tasks. During these tasks, my eye movements, face, and voice will be recorded. I will be compensated $20 for participating in this session. During one of the tasks, I will have an opportunity to win up to $5 extra for my performance. In total, I will be compensated up to $25.

The researchers would like permission to access my medical records in order to document my diagnoses and prior hospitalizations. I have the option of either giving or not giving the researchers the right to access my medical records, depending on my comfort level. There will be no penalty, reduction in compensation, or other issue for my decision either way.

For parts of this study, I will be audio and video recorded. I realize that I can deny permission to be video recorded and still participate in the study. However, audio recording is central to the study, so I need to be comfortable with this.

For part of this study, I will have my eye movements tracked using a camera mounted on the computer monitor. This camera, referred to as an "eye-tracker" uses an invisible infrared light that shines a weak spot of light on the retina. The eye-tracker used in this study is approved by certified labs according to the European standard for optical radiation, IEC/EN 62471, and is not harmful to the human eye. The eye-tracker will be worn for approximately 10 minutes.

For five minutes of the study, I will be asked to wear a special cap that measures brain activity (called an Electro-encephologram (EEG). This cap measures can measure how alert or awake I am, but it can't be used tell what I am thinking about. We are interested in understanding how active your brain is when you sit quietly with your eyes closed, and when you are playing some games. There is no risk of shock, abrasion or injury from using this cap.

Benefits: I understand that I will not directly benefit from participating in this study. My participation will help researchers develop new tools for measuring mental illness.

Risks/Discomforts: This study may be inconvenient in that it will take some of my time. I also recognize that I will be asked to talk about my mental health history, and that my eye movements, face, and voice will be recorded during some parts of this study. At no time will these recordings be shared with anyone not involved with the study. These recordings will be destroyed at the end of the study. I also recognize that I will be shown several images that may be uncomfortable to some people.

Right to Refuse: Participation in this study is voluntary. I may refuse to answer any questions or discontinue any test I am taking. Further, I can change my mind and withdraw from this study at any time without risking my relationship with Louisiana State University or any group homes or Mental Health clinics. I also recognize that I can contact the researchers at any point after the study is complete to have my paper, audio, and video-taped records destroyed.

Privacy: All information obtained in this study will be kept confidential. That means my information will not be shared with anyone, unless legally compelled. Limits to confidentiality include situations where an individual is at risk of hurting themselves (e.g., suicide) or hurting someone else (e.g., homicide, child abuse). I understand that the investigators are required by law to report any reasonable suspicions.

My records will be kept in a locked laboratory in a secure facility. Electronic data will be entered without identifying information and will be password protected. To ensure confidentiality, I will be assigned a number. All information collected during this study will be linked to this number and kept separate from any identifying information such as my name. Results of the study may be published, but no names or identifying information will be included for publication.

The researchers are applying for a Certificate of Confidentiality from the National Institute of Health (NIH). This Certificate will protect the investigators from being forced to release any research data in which I am identified, even under court order or subpoena, without my written consent. This protection does not affect the investigators' legal responsibility to report information about suspected or known sexual or physical abuse of a child or about your expression of a clear and present danger of harming yourself or others to proper authorities. The Certificate does not prevent me or a member of your family from voluntarily releasing information about myself or my involvement in this study.

Financial Information: I will receive $20 cash for completion of the single session. Additionally, for one of the attention games in this study, I can win up to $5 extra based on my performance.

Signatures: The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Dennis Landin, Ph.D., Chairman, LSU Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and I understand that the research must provide me a copy of this consent form if signed by me.

________________________________ ________________________

Participant Signature Date

Please initial one of the following:

I give ________________ or do not give ________________ permission for the researchers to access my medical records.

___________________________________ ________________________

Participant Signature Date

Research Assistant: please indicate whether the consent form was read to the participant.

(Check One)

_________ I certify that I have read this consent form to the participant and explained that by completing the signature line above, he/she has agreed to participate (*NOTE – Consent form should be read to all patient participants)*.

_________ The participant will be enrolled as a control and is English-literate. The participant refused my offering to read this consent form to them.

___________________________________ ________________________

Signature of Research Assistant Date

___________________________________ ________________________

Signature of Principal Investigator Date

VITA

Kyle Mitchell was born and raised in St. Louis, Missouri. He relocated to Austin, Texas for college, where his interest in clinical psychology began. He relocated to Baton Rouge, Louisiana for graduate school to research cognitive and emotional functioning in individuals with Severe Mental Illness. Upon graduation with his Ph.D., Kyle plans to move to San Diego, California to pursue his research goal of as a postdoctoral fellow at the VISN 22 Mental Illness Research, Education, and Clinical Centers of Excellence at the VA San Diego Healthcare System researching the role of inflammation and mood variability in individuals with Severe Mental Illness.