Secondary Control Coping in Youth: Testing A Novel Experimental Paradigm

By

Alexandra Hall Bettis

Dissertation

Submitted to the Faculty of the

Graduate School of Vanderbilt University

In partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in

Psychology

June 30, 2018

Nashville, Tennessee

Approved:

Bruce Compas, Ph.D.

Judy Garber, PhD

David Cole, Ph.D.

Sarah Jaser, Ph.D.

Mark Wallace, Ph.D.

ABSTRACT

Coping and emotion regulation is a central feature of risk and resilience in childhood and adolescence. More specifically, secondary control coping strategies, including acceptance, distraction, and cognitive reappraisal, have been linked to lower levels of internalizing and externalizing psychopathology in youth across development. These processes have been predominantly assessed by questionnaire methods, primarily self-report and to a lesser degree parent-report of youths coping. The current study aimed to address gaps in the field of the measurement of coping and emotion regulation in youth by testing a novel experimental coping and emotion regulation paradigm in a community sample of youth (N = 56; ages 9-15). The laboratory paradigm assessed the use of distraction and reappraisal in response to images of parental distress (i.e., family stress). The current study used both questionnaire and laboratory measures of secondary control coping (performance on the laboratory task), and examined associations among stress, coping, brain activation and negative emotion during the laboratory task, and internalizing symptoms. Findings indicate that use of distraction and reappraisal during the laboratory paradigm was associated with lower levels of negative emotion during the paradigm. Findings also indicate that youth use of distraction in the laboratory task, but not reappraisal, was associated with self-report measures of secondary control coping in response to family stress. Youth prefrontal brain activation did not differ as a function of condition in the laboratory task, and internalizing symptoms were not associated with laboratory measures of secondary control coping. Future research utilizing both questionnaire and laboratory methods to assess coping and emotion regulation in youth will be important for understanding these processes as possible mechanisms of risk and resilience.

TABLE OF CONTENTS

iv

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

BACKGROUND

Exposure to stress is a significant risk factor for psychopathology in youth (e.g., Evans, Li, & Whipple, 2013; Grant et al., 2003). However, there are large individual differences in the effects of stress, as some individuals develop symptoms of psychopathology while others do not. How youth cope with and regulate emotions in response to stress is a central feature for understanding individual differences in risk and resilience childhood and adolescence (Compas et al., 2017). In spite of the importance of coping and emotion regulation in research on risk and resilience for psychopathology, to date, the measurement of coping has largely relied on questionnaire measures to obtain youth self-report and parent report of these processes. While these measures have consistently shown associations with symptoms of psychopathology in youth, reliance on questionnaire measures is subject to a number of limitations including potential shared method variance in the association between coping and symptoms, possible biases in the information that can be provided by children and parents, and limits in understanding the neurobiological underpinnings of the ways in which youth cope with stress (Folkman & Moskowitz, 2004). The current study addresses these limitations by examining a novel laboratory paradigm to examine coping and emotion regulation and brain activation in children and adolescents.

Coping and Emotion Regulation

Coping and emotion regulation in response to stressors are a key feature in the development of symptoms of psychopathology across the lifespan and thus a viable target for preventive interventions (Compas et al., 2017). Coping is defined as a set of conscious, controlled processes that aim to regulate emotions, thoughts, behaviors, and physiological

responses in the face of stressors (Compas et al., 2001). Drawing on prior research by Weisz and colleagues on perceived control (e.g., Weisz, McCabe, & Dennig, 1994), a control-based model of coping includes three factors: primary control coping, referring to efforts to directly change or control a stressor or emotions in response to a stressor; secondary control coping, referring to efforts to adapt to a stressor; and disengagement coping, referring to efforts to disengage from or avoid a stressor (Compas et al., 2001; Connor-Smith et al., 2000). This three-factor control-based model of coping has been supported in children, adolescents and adults, with several confirmatory factor analyses across multiple different cultural and ethic groups facing different stressors ranging from minor events and daily hassles to family stress to coping with chronic illness and war-related trauma (e.g., Benson et al., 2011; Compas et al., 2006a, 2006b; Connor-Smith & Calvete, 2004; Wadsworth et al., 2004; Xiao et al., 2010).

The closely related construct of emotion regulation includes processes or strategies that individuals employ to change the duration or magnitude of an emotional response (Gross & Thompson, 2007), including emotions that are experienced in response to stressful events or chronic adversity (e.g., Aldao, Nolen-Hoeksema, & Schweizer, 2010; Joormann & Vanderlind, 2014). While no studies have offered or tested a structural framework of emotion regulation, strategies encompassed in a process model of emotion regulation include antecedent-focused strategies, which influence an emotion before it is fully formed, and response-focused strategies, which influence an emotion once it has been fully developed (Gross, 2003; Gross & Jazaieri, 2014; Gross, Sheppes, & Urry, 2011). Notably, the three-factor coping model described above includes strategies that are captured under the broad constructs of both coping *and* emotion regulation, suggesting that there is considerable if not complete overlap between these two constructs (Compas et al., 2017).

The present study focused specifically on secondary control coping strategies, which include acceptance, cognitive reappraisal, positive thinking, and distraction. The secondary control coping factor encompasses those efforts that are intended to reduce stress by adapting to the source of stress, rather that directly act upon or change the stressor (Compas et al., 2001). As such, secondary control coping strategies are considered most useful in response to uncontrollable stress. As reviewed below, secondary control coping strategies have been linked to lower levels of symptoms of psychopathology in youth, and may be an important transdiagnostic intervention target for children and adolescents (e.g., Bettis, Forehand, McKee, Dunbar, Watson, & Compas, 2016; Compas, Gruhn, & Bettis, 2016; Compas, Watson, Reising, & Potts, 2013).

Secondary Control Coping and Psychopathology in Youth

A large body of research supports the association between coping and emotion regulation and symptoms of psychopathology in children and adolescents. Most recently, Compas and colleagues (2017) conducted the largest comprehensive meta-analysis of coping and emotion regulation and internalizing and externalizing psychopathology in children and adolescents to date. This meta-analysis examined effects from over 240 studies of children and adolescents ($N =$ 80,850, ages 5-18 years) across broad *domains* of coping and emotion regulation, intermediate level *factors* of coping and emotion regulation, and specific coping and emotion regulation *strategies*. Studies included in this meta-analysis utilized self-report, parent-report, and teacher-report questionnaire measures of both coping and symptoms in youth. Relevant to the current study, significant negative associations were found between secondary control coping and internalizing psychopathology. Effect sizes for secondary control coping effects ranged from $r =$ -.21 to -.30. However, findings at the specific strategy level were more limited, with little to no

support for specific secondary control coping strategies including cognitive reappraisal, acceptance, and distraction (Compas et al., 2017).

Consistent with the meta-analysis described above, secondary control coping has demonstrated significant negative associations with overall internalizing symptoms in a number of child and adolescent samples (e.g., Bettis et al., 2016; Compas et al., 2014; Dunbar et al., 2013; Jaser et al., 2011). Further, research suggests secondary control coping strategies are transdiagnostic correlates of anxiety and depression in youth (Bettis et al., 2016), indicating that they may be a particularly important set of strategies to understanding the development and maintenance of a wide range of symptoms of different psychological disorders in youth. Further, because coping and emotion regulation are comprised of skills that can be feasibly taught/learned across development, these skills are an important point of potential intervention for the prevention or treatment of internalizing problems in youth.

Consistent with the emphasis in the Research Domain Criteria (RDoC; Insel & Cuthbert, 2015) on examining underlying neurobiological processes, functional neuroimaging studies have identified brain regions associated with the use of secondary control coping strategies, primarily the cognitive reappraisal and distraction. Regions thought to be important in the top-down regulation of emotion and cognitive control have been identified in studies of cognitive emotion regulation. Commonly identified regions include the dorsolateral prefrontal cortex (dlPFC) and ventrolateral prefrontal cortex (vlPFC), dorsal regions of the anterior cingulate cortex (dACC), and the posterior dorsomedial prefrontal cortex (dmPFC), among others (Goldin et al., 2009; McRae et al., 2009; Ochsner et al., 2002, 2004).

With regard to reappraisal, the dlPFC and inferior parietal network (i.e., frontoparietal network) have been identified as regions associated with directing attention to reappraisal-

relevant stimuli, maintaining reappraisal goals, and manipulating information during reappraisal (Belden et al., 2015; Ochsner et al., 2002; Wager & Smith, 2003). Areas of the dorsal ACC are considered important in monitoring and changing emotional responses during the reappraisal process. Similarly, the dmPFC is thought to support reappraisal of emotional stimuli and monitoring emotional state (Lane & McRae, 2004; Ochsner et al., 2004). Further, the vlPFC is thought to select goal-appropriate responses and inhibit goal-inappropriate responses when selecting a new reappraisal of a presented stimulus (Thompson-Schill et al., 2005). While fewer studies have examined distraction in the context of an emotion regulation paradigm, similar regions have been identified as important in the implementation of this skill. Namely, the dlPFC (BAs 9, 46) and superior frontal gyrus (BA6) have been identified as common regions activated across cognitive emotion regulation strategies (Dorfel et al., 2014).

Measurement of Coping and Emotion Regulation

      Questionnaire measurement. Both coping and emotion regulation encompass a wide range of strategies and subtypes, as reflected in the large number of measures currently used in the research. Questionnaire measures, primarily self-report, have been the predominant method used to assess coping in childhood and adolescence. These measures vary in the stressor or precipitant they assess (e.g., stressors in general vs. stressors associated with a specific event or circumstance), informant, and the number of strategies assessed (Compas et al., 2017). For example, Skinner et al. (2003) identified over 400 subtypes of coping from over 100 measures, indicating the lack of consensus across the field in regard to the structure and measurement of coping, and despite the heterogeneity of measures within the field, new measures continue to be developed (e.g., Sveinbjornsdottir & Thorsteinsson, 2014). Similar to the measurement of coping, over 100 questionnaire measures of emotion regulation in children and adolescents have

been identified, suggesting a similar problem as found in the coping literature (Adrian et al., 2011). Most measures of emotion regulation either focus on two or three specific strategies (e.g., Emotion Regulation Questionnaire; Gross & John, 2003) or ask how individuals broadly manage emotions without specifying the strategy for doing so (e.g., Emotion Regulation Checklist; Shields & Cicchetti, 1998). In addition, the most frequently measured coping and emotion regulation strategies include cognitive reappraisal, distraction, avoidance, and emotional suppression (Compas et al., 2017).

Although questionnaires are the most widely used method to assess coping and emotion regulation in childhood and adolescence, these measures have several limitations. First, self-report measures are potentially biased due to difficulty with and variability in recall (Folkman & Moskowitz, 2004). Second, self-report measures of coping and emotion regulation are plagued by problems with shared method variance and cofounding of items with measures of symptoms of psychopathology. When a measure of coping and psychopathology come from the same source, associations may become inflated due in large part to method bias (Podsakoff, MacKenzie, & Podsakoff, 2012). Third, a number of studies using self- and parent-report measures have used measures with limited or poor psychometric data; in the meta-analysis conducted by Compas et al. (2017), over half of the included studies used measures with no reported validity data. In addition, measures used to assess coping and emotion regulation in youth are frequently developed as measures of coping and emotion regulation in adults rather than youth and have not been validated in child or adolescent populations (see Compas et al., 2017 for review). Finally, while there have been some efforts to link self- and parent-report measures of coping and emotion regulation with physiological measures that may be associated with these processes (e.g., Jaser et al., 2016), there remains a significant gap in the research

regarding links between questionnaires and laboratory measurement of coping and emotion regulation in children and adolescents.

Laboratory measurement. Despite reliance predominantly on self- and parent-reports in the measurement of coping and emotion regulation, research on emotion regulation has also included laboratory-based measurement to better understand these processes. Paradigms have been developed that show participants emotionally evocative stimuli in order to assess how participants regulate the experience of negative emotions in real time. In addition, laboratory paradigms allow for the measurement of brain activation (or other psychophysiological or neurobiological mechanisms) while participants are engaging in coping and emotion regulation strategies, offering the opportunity to assess the neural underpinnings of how individuals cope with and regulate emotions in response to stress.

The primary strategy examined in emotion regulation lab paradigms is cognitive reappraisal. Cognitive reappraisal involves reinterpreting or reframing the way a person thinks about a situation in an effort to reduce negative emotion or make a situation less stressful. In laboratory paradigms, participants are instructed to think about the stimulus in a way to make the image feel less negative or stressful; e.g., think the image is not real, the things depicted in the image will get better, or things depicted in the image are not as bad as they appear (e.g., McRae et al., 2009; Ochsner et al., 2004). Reasons for studying reappraisal in response to a laboratory task are threefold: (1) the use of reappraisal has been linked to lower levels of symptoms of anxiety and depression in youth and adult populations (Compas et al., 2017); (2) cognitive-behavioral interventions emphasize cognitive reappraisal as a key skill in the treatment and prevention of psychopathology (e.g., Compas et al., 2010; Garber et al., 2009); and (3) this skill requires flexible thinking and may draw on similar brain regions of activation as other cognitive

tasks (e.g., Andreotti et al., 2013; Reising, Bettis, et al., 2017; Robinson et al., 2015). Other strategies that have been assessed through laboratory paradigms include distraction, distancing or self-focused attention, and suppression of emotional expression (e.g., Goldin et al., 2008; McRae et al., 2009). Studies utilizing these methods to examine coping and emotion regulation in the laboratory are described in more detail below.

In one of the first examples of this approach, Ochsner et al. (2002) adapted a paradigm used to study the fear-potentiated startle eye response (Jackson et al., 2000) to examine the cognitive regulation of emotion (i.e., cognitive reappraisal). In this paradigm, a sample of 15 female adults was instructed to either attend to the stimulus and experience the emotions as they would naturally (i.e., react) or reappraise the image to feel less negative. Participants were presented either a neutral or negative image for 4 seconds, with instructions either to attend or to reappraise each photo. After each stimulus presentation, participants rated their current level of negative affect. Negative affect ratings were significantly lower on reappraise trials compared to attend trials when presented with negative stimuli. In addition, brain activation was measured using functional magnetic resonance imaging (fMRI), and results revealed that prefrontal regions displayed greater activation in prefrontal regions during reappraisal as compared to attend trials in response to negative images, including the dorsolateral prefrontal cortex (dlPFC) and ventralateral prefrontal cortex (vlPFC), and dorsomedial prefrontal cortex (mPFC) (Ochsner et al., 2002).

Following this initial study, Ochsner et al. (2004) examined emotion regulation in a sample of 24 female young adults using a similar paradigm. Participants were randomized to one of two conditions: (1) a self-focused condition in which participants were instructed to imagine themselves in a situation and either increase negative affect (i.e., imagine themselves in the scene

depicted) or decrease negative affect (i.e., view from a detached, third person perspective) or (2) a situation-focused condition in which participants were instructed to reinterpret the presented images and increase negative affect (i.e., imagine events getting worse) or decrease affect (i.e., imagine events getting better). Participants were presented with a series of negative and neutral images from the International Affective Picture System (IAPS; Lang, Greenwald, Bradley, & Hamm, 1993) and rated their level of negative affect following each stimulus presentation. Importantly, participants were trained on the use of reappraisal to increase or decrease affect 3-5 days prior to study participation; this training included written instructions and practice trials where participants were given feedback regarding their reappraisals. A significant main effect for type of instruction emerged, such that negative affect ratings were significantly greater in the increase trials compared to the decrease trials; there was no difference in emotion ratings for the self-focused compared to other-focused conditions. Further, fMRI was used to assess brain activation during the task, and activation during reappraisal trials indicated significant activation in prefrontal regions (dlPFC, vlPFC, dmPFC, and the anterior cingulate cortex; ACC). Further, planned comparison *t*-tests of measures of block average signal change showed that during reappraisal trials, the self-focused group showed greater activation in the right medial PFC while the situation-focused group showed greater activation in the left and right lateral PFC (Ochsner et al., 2004).

Since the initial development of these laboratory paradigms to assess emotion regulation and brain activation, a number of studies have examined emotion regulation using similar tasks in adults. The majority of studies have used paradigms to assess cognitive reappraisal in comparison to emotional reactivity (i.e., look at a picture and react normally) and/or other emotion regulation strategies (i.e., suppression, distraction) in response to negative stimuli. For

example, McRae et al. (2008) examined gender differences in cognitive reappraisal and brain activation in a sample of young adults. Participants were shown a series of 90 negative or neutral images drawn from the IAPS and instructed to either reappraise the image to decrease negative affect or react as they normally would to the image. Negative images elicited greater levels of negative emotion than neutral images when participants were instructed to react to the stimuli, indicating the negative images selected evoked negative affect in participants. Further, negative affect was significantly greater in the react trials compared to the reappraisal trials. Further, fMRI results showed that participants also had greater activation in the anterior cingulate; superior, middle, and inferior frontal gyri; inferior parietal lobule; and the superior and inferior temporal gyri during reappraisal trials (McRae et al., 2008).

In a sample of adult females, McRae et al. (2009) compared two emotion regulation strategies, reappraisal and distraction. The paradigm mirrored that used by McRae et al. (2008), with an additional condition in which individuals were instructed to use distraction by engaging in a working memory task (i.e., keep a string of 6 letters in mind during the picture presentation). Results indicated that reappraisal led to greater reduction in negative affect compared to distraction, and both reappraisal and distraction led to greater reduction in negative affect when compared to the react condition in response to negative stimuli (McRae et al., 2009). Greater activation during both reappraisal and distraction as compared to the react condition was indicated in the superior frontal gyrus, middle frontal gyrus, and inferior frontal gyrus. Further, several regions were identified as demonstrating greater activation in the reappraisal condition relative to the distraction condition, including clusters within the dmPFC and vlPFC. A smaller number of regions were identified as showing greater activation during distraction compared to reappraisal, including the superior parietal lobule, a region within the middle frontal gyrus, and

the precentral gyrus. Lastly, activation in several regions was significantly correlated with lower negative affect ratings during both the reappraisal and distraction conditions, including the superior and middle frontal gyrus and the superior parietal lobule (McRae et al., 2009).

Goldin et al. (2008) examined reappraisal and suppression using a paradigm that presented film clips intended to evoke disgust in adults (i.e., surgical procedures, vomiting, animal slaughter). Thirty disgust-inducing film clips and 40 neutral nature scene film clips were shown to participants, who were instructed to reappraise or suppress the expression of emotion while viewing the stimuli. Results showed that participants experienced higher levels of negative affect when viewing the disgust films as compared to neutral films, and negative affect during the disgust films varied as a function of condition. That is, negative affect was significantly lower during the reappraisal condition when compared to both the react and suppression conditions. In regard to activation in prefrontal regions, a significant condition x time interaction emerged, indicating that reappraisal generated significant early activation in the prefrontal cortex (PFC), whereas suppression produced late PFC activation during the presentation of the film stimuli (Goldin et al., 2008).

In an effort to bridge questionnaire and laboratory measurement of emotion regulation, Drabant et al. (2009) examined associations between brain activation during a laboratory paradigm and self-reported emotion regulation in daily life. A sample of 56 adult females completed a laboratory paradigm during which participants viewed either negative faces expressing fear or anger or geometric shapes. During the task, participants had to match one of two faces or two shapes displayed on the bottom of the screen to a face or shape on the top of the screen. Participants also completed the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003), a self-report measure of reappraisal and suppression of the expression of emotion, and a

self-report measure of anxiety. Self-reported reappraisal use on the ERQ was associated with greater prefrontal activation in the negative emotion face task, after controlling for anxiety (Drabant et al., 2009). Notably, in this task, participants were not instructed to explicitly use emotion regulation strategies while viewing the stimuli.

Altogether, studies with healthy adult samples indicate that laboratory paradigms can elicit negative emotions in adults, and when instructed to use reappraisal or distraction, adults report experiencing lower levels of negative emotion while viewing stimuli. Further, findings from fMRI indicate regions of the prefrontal cortex are associated with the use of reappraisal and distraction. Namely, studies of emotion regulation paradigms in adults have shown the use of reappraisal is associated with activation in the dlPFC, vlPFC, mPFC, and dACC. A smaller number of studies examining distraction have also found these cognitive control regions to be implicated in the use of distraction; however, there is some evidence to suggest that reappraisal is associated with greater activation compared to distraction in some prefrontal regions given it is considered a higher level cognitive strategy (e.g., McRae et al., 2009).

Clinical samples of adults. Laboratory emotion regulation paradigms have also been utilized in adult clinical samples. In a study comparing adults met clinical criteria for Social Anxiety Disorder (SAD) and healthy control participants with no history of SAD, participants completed a paradigm in which participants were read four autobiographical stressful situations and asked to rate their negative emotion after each statement (Goldin et al., 2009). Participants were instructed to either react or use reappraisal to reframe negative beliefs about the self while completing the paradigm. Participants with SAD reported higher levels of negative emotion during react trials compared to healthy controls; however, negative emotion was significantly reduced for both healthy control and SAD adults when instructed to reappraise the negative self-

statements. Whole brain analyses of fMRI during the task showed brain responses in regions of the prefrontal cortex (dmPFC, dlPFC) early in the process of hearing the negative statements, and later responses in regions associated with cognitive control (dACC). Further, healthy control subjects showed greater early responses in regions implicated in reappraisal (dmPFC, dlPFC) as compared to participants with SAD (Goldin et al., 2009).

In a randomized controlled trial for adults with SAD, Goldin et al. (2014) employed a Social Evaluation Task (SET) in order to evaluate reappraisal in the face of social criticism. The task utilized 12-second video clips of actors verbalizing and visually expressing either social criticism or social praise, stimuli that have particular salience to individuals with SAD. During criticism trials, participants were instructed to either reappraise the criticism or just watch followed by a rating for their level of negative emotion. Participants completed the task prior to enrolling in a randomized control trial for the treatment of SAD (randomized to CBT or wait-list control) and at post-intervention. A significant group x time interaction emerged during the reappraise criticism trial of the SET, indicating that participants in the CBT condition reported significantly lower negative emotion ratings from pre- to post-CBT compared to participants in the waitlist control condition. Further, results showed a significant group x time interaction for brain activation, indicating significant increases pre-to-post for participants in the CBT condition in the superior and middle frontal gyrus and middle occipital gyrus. However, an opposite pattern emerged for the CBT group in the left posterior superior temporal gyrus, indicating a significant decrease in activation pre- to post-intervention for the CBT group. Finally, changes in negative emotion ratings and brain activation during the reappraisal condition from pre- to post-intervention for participants in the CBT condition were significant predictors of change in social anxiety symptoms from pre- to post-intervention (Goldin et al., 2014). Importantly, the task used

by Goldin and colleagues (2009, 2014) is one of the first to employ stimuli relevant to daily experiences by participants, and indicate responses to these stimuli may be sensitive to detecting effects of intervention.

In a sample of adults with a history of depression and never-depressed adults, participants completed an emotion regulation task in which they viewed sad images and were asked to use reappraisal or attend/react and report their negative affect following each image (Smoski et al., 2013). Both the depressed and non-depressed participants reported lower negative affect during reappraisal compared to react trials. However, depressed participants demonstrated relatively lower activation in the right middle frontal gyrus (BA 6) as compared to the healthy control participants during reappraisal trials. The depressed participants group also showed relatively greater activation in the right paracingulate gyrus (BA 32 within rostral ACC) compared to healthy controls during reappraisal trials. Specifically, during reappraisal of sad images, the depressed participants showed significantly lower levels of activation in the middle frontal gyrus cluster. In addition, the healthy control group showed greater activation during reappraisal relative to neutral images, while the depressed group showed greater activation in the rACC cluster during reappraisal of sad images. However, no significant correlations were found between brain activation in the specified regions (middle frontal gyrus and rACC clusters) and self-reported negative affect during the task in this sample (Smoski et al., 2013).

In summary, findings from adult clinical samples are limited. These studies suggest that there may be differences in prefrontal activation in clinical populations as compared to non-clinical populations. However, these differences are still not well understood, and further research in clinical samples is needed in order to better understand whether differences do exist and whether these differences are meaningful indicators of risk for or the presence of emotional

or behavioral difficulties. In addition, results from Goldin and colleagues (2009, 2014) suggest that patterns of activation during the employment of emotion regulation strategies may change as a function of a cognitive-behavioral intervention and may predict symptom change over time. However, further research is needed to replicate these findings and examine whether findings are specific to certain clinical populations.

      Laboratory measurement: Child and adolescent samples. A limited number of studies have examined laboratory emotion regulation paradigms in children and adolescents. In a study of adolescents and young adults, McRae et al. (2012) examined cognitive reappraisal and emotional reactivity in response to a lab-based emotion regulation task. In a sample of 10-13 year olds ($n = 12$), 14-17 year olds ($n = 10$), and 18-23 year olds ($n = 16$), the study examined brain activation while completing a reappraisal task. Participants viewed negative images from the IAPS for 8-seconds each and were instructed to either decrease (reappraise) or attend to (react) the image. Prior to completing the task, participants completed a practice session where the participant narrated out loud his or her reappraisal thoughts, and feedback was given if participants had difficulty providing reappraisal thoughts. Results showed a significant association between reappraisal success and age, such that older participants reported significantly less negative affect during reappraisal trials compared to adolescents. Consistent with previous studies in adult samples, youth showed significant activation in emotion-related regions of the brain, including the amygdala and insula, during the look trials. Further, significant activations in the bilateral prefrontal, parietal, and temporal regions were observed during reappraisal trials, which is also consistent with studies of adults using these paradigms. In addition, linear effects of age were found for activation in the fusiform gyrus and vmPFC cortex, such that activation increased with age (McRae et al. (2012).

In a younger sample, Dougherty et al. (2015) enrolled children ages 4 to 10 years old in a laboratory study of emotion regulation. Children viewed 45 negative images and 15 neutral images from the IAPS (Lang et al., 1993) and were instructed to attend, increase, or decrease their emotion while looking at the pictures. Participants were presented with a brief story containing the attend, increase, or decrease instructions prior to viewing the image (i.e., "this family won a big prize and is so happy they are crying" vs. "this family just lost their home in a fire and is sad and crying"). The story was read aloud from the computer to the participants for 5 seconds followed by a 2.5 second stimulus presentation. Children rated their negative affect after each image was presented on a 5-point scale. Participants completed eight practice trials prior to the experimental task. Results showed that children reported significantly lower negative affect in the decrease condition (i.e., positive appraisal) compared to both the increase condition (i.e., negative appraisal) and attend trials when viewing negative stimuli. Results from fMRI revealed children had significantly greater activation in the vmPFC and amygdala during reappraisal trials (both positive and negative) compared to attend trials (Dougherty et al., 2015).

Belden et al. (2014) examined cognitive emotion regulation of sad affect in a sample of 19 healthy children and adolescents (ages 8 to 12). Neuroimaging results were consistent with adult samples, indicating greater activation in prefrontal regions (vlPFC, dlPFC, dmPFC) and less activation in emotion regions (amygdala) during reappraisal compared to attend trials. In addition, Belden et al. (2015) examined cognitive emotion regulation and brain activation in a sample of 64 youth with and without a history of depression (ages 7 to 15). Youth viewed sad and neutral images from the IAPS, and during the image presentation youth were instructed to either attend to the image (just look) or reappraise (make positive) the images. Images were presented with instructions for 4 seconds, and then the instruction cue (just look or make

positive) remained on the screen for 4 additional seconds. Following the 8-second interval, participants reported both positive and negative affect. Differences in positive affect on reappraisal versus react trials approached significance, however, there was no interaction for diagnostic status (depressed vs. non-depressed) and emotion ratings on during react compared to reappraise sad trials. Both groups showed greater activation in prefrontal regions (vlPFC, dlPFC, dmPFC) and parietal and temporal lobe regions in the reappraise trials compared to react trials when viewing sad images. When compared across groups and condition, healthy control youth showed greater activation in reappraisal trials compared to youth with a history of depression in only one of 23 regions of interest (Belden et al., 2015).

      Associations between self-report and laboratory measures. A small number of studies have examined the association among self- and parent-reports of coping and emotion regulation in youth and brain activation during a non-emotional working memory task. For example, Robinson et al. (2015) examined brain activation using fMRI during a standard n-back task in a sample of youth diagnosed with brain tumors and healthy control youth (ages 8-16 years) and the association of patterns of brain activation with coping and mixed anxious/depressed symptoms. Results showed significant associations between brain activation in the prefrontal regions and secondary control coping. Specifically, higher levels of secondary control coping were associated with greater activation in the dlPFC, anterior prefrontal cortex (aPFC), and superior frontal gyrus during the working memory task in both samples. Further, secondary control coping was also significantly negatively associated with mixed anxiety/depression symptoms for both samples (Robinson et al., 2015).

      In a sample of 16 children of depressed and non-depressed parents (ages 12-15), Reising et al. (2017) examined brain activation in response to the same non-emotional n-back task used

by Robinson et al. (2015) and secondary control coping in response to family stress. Secondary control coping was significantly negatively correlated with brain activation in the dlPFC, aPFC, and dACC during the n-back task. Further, in linear regression analyses, activation in the aPFC and dACC significantly negatively predicted youth secondary control coping after controlling for parent depression history and exposure to chronic stress (Reising et al., 2017). However, it is noteworthy that no studies in a child and adolescent sample have examined associations among self-reported secondary control coping and brain activation during an emotion regulation task.

Taken together, findings from laboratory-based emotion regulation paradigms suggest that coping and emotion regulation strategies, particularly those clustered within the secondary control coping factor (reappraisal, acceptance, distraction), are measurable in the lab and allow for the assessment of neurobiological mechanisms implicated in coping and regulating emotions. Paradigms have followed a relatively similar structure, with the presentation of either static (pictures) or dynamic (film clips) stimuli to evoke negative emotion more broadly or specific negative emotions (i.e., disgust, sadness) in participants. Stimuli are paired with instructions to either react to the stimuli (e.g., just look, attend) or manipulate thoughts or behavior in response to the stimuli (e.g., reappraise, suppress, distract). Presentation of stimuli is generally followed by ratings of negative affect on a Likert scale. Functional neuroimaging techniques are used to assess activation in prefrontal (and emotion-related) regions during the task. Consistent evidence has shown that these paradigms elicit negative emotion in adults and youth and emotion reported differs during the task based on simple instructions to regulate affect (e.g., reappraise) or react (e.g., just look). Further, there is consistent evidence that these paradigms activate several brain regions implicated in both cognitive executive functioning and emotion regulation, including

regions in the dlPFC, vlPFC, dmPFC, and dACC (e.g., Goldin et al., 2009; 2012; McRae et al., 2008, 2012; Ochsner et al., 2002, 2004).

However, these studies have largely been conducted in adult populations, and therefore, our understanding of how youth regulate emotions in real time, including patterns of brain activation when utilizing specific regulation strategies such as reappraisal or distraction in children and adolescents is limited. Further, studies using lab-based paradigms to assess emotion regulation have in large part relied on non-specific negative stimuli (i.e., generic images from the IAPS) to elicit negative affect in participants. While studies have shown that these negative images can evoke negative affect and thus allow for reappraisal or distraction strategies to be implemented in order to regulate the affective experience, few studies have examined paradigms using images that depict real life stressors (see Goldin et al., 2014, for an exception) or whether findings generalize to the stress actually experienced by individuals in their daily lives (i.e., Drabant et al., 2009).

Therefore, the current study aims to extend findings from previous studies by examining two secondary control coping strategies in a laboratory paradigm targeting stress specific to children and adolescents, particularly stress in the family. This approach builds on a large literature on coping and emotion regulation in response to family stress in children and adolescents (e.g., Bettis et al., 2016; Dunbar et al., 2013; Fear et al., 2009; Wadsworth & Compas, 2002). The use of stimuli specific to stress experienced by youth allows for a better understanding of brain activation when coping with real life stress as well as provides an opportunity to assess potential mechanisms of symptom change as a function of interventions teaching youth to cope with stress. No studies to date have examined the use of secondary control coping strategies specifically to manage family stress, including stress related to parental

distress, and brain activation using a laboratory paradigm. Further, no studies have examined how emotion ratings and/or brain activation during a task specific to family stress is associated with a parallel self-report measure of coping and emotion regulation in youth.

Study Aims and Hypotheses

The current study examined the development of a novel coping and emotion regulation paradigm and its associations with levels of family stress, secondary control coping in response to family stress, brain activation, and symptoms of anxiety and depression in a community sample of children and adolescents ages 9 to 15 years-old (see *Figure 1* for overall heuristic model).

Primary aims. The current study aimed to examine the following questions with regard to a novel coping and emotion regulation paradigm: (1) Do negative emotion ratings differ between task conditions in the laboratory paradigm? (2) Does brain activation in prefrontal regions differ as a function of condition in the laboratory paradigm? (3) Are emotion ratings during the manipulation conditions of the laboratory paradigm associated with perceived levels of family stress and self-reported use of secondary control coping in response to family stress in daily life?

Hypotheses. (1a) Youth will report significantly higher mean levels of negative emotion during each of the three conditions in the laboratory task with emotional images (i.e., reappraise, distract, and react-negative conditions) compared to the condition with neutral images. (1b) Youth will report differential levels of negative emotion across conditions for the emotional image trials of the laboratory paradigm. Specifically, during trials presenting emotional images (i.e., images of adults looking sad or mad), youth will report significantly lower mean levels of negative emotion in the reappraisal and distraction conditions compared to the react condition.

(1c) Further, during emotional images trials, there will be no difference in reported mean levels of negative emotion between the reappraisal and distraction conditions.

(2a) Youth will demonstrate greater change in activation (increases) in prefrontal regions of the brain in response to emotional images across the reappraise, distract, and react conditions when compared to resting state (baseline) activation. (2b) Youth will demonstrate greater change in activation (increases) in prefrontal regions of the brain in response to reappraise and distract conditions in contrast to react trials when presented with emotional stimuli. (2c) Lastly, youth will demonstrate greater change (increases) in activation in the prefrontal regions of the brain in the reappraise condition compared to the distract condition.

(3a) Youth reports of family stress will be significantly positively correlated with negative emotion ratings during the three task conditions with emotional stimuli, such that higher levels of family stress will be associated with higher negative emotion ratings. (3b) Youth self-reports of secondary control coping in response to family stress will be significantly negatively associated with mean emotion ratings in the reappraisal and distraction trials of the laboratory paradigm, such that reports of greater use of secondary control coping on the RSQ will be associated with lower self-reported negative emotion in both the reappraisal and distraction conditions.

Secondary aims. In addition, the current study will explore the associations between secondary control coping, negative emotion ratings during the laboratory paradigm, and youth symptoms of anxiety and depression. These analyses will examine: (4) Are negative emotion ratings during the laboratory paradigm associated with youth symptoms of anxiety and depression? (5) Do emotion ratings during the coping and emotion regulation paradigm and self-

reported secondary control coping account for significant variance in youth symptoms of anxiety and depression symptoms?

Secondary hypotheses. (4) Negative emotion ratings when viewing emotional stimuli (i.e., reappraise, distract, and react-negative conditions) will be positively associated with internalizing symptoms, such that higher ratings of negative emotion during the laboratory task will be associated with higher levels of internalizing symptoms in youth. (5) Levels of family stress, secondary control coping, and mean negative emotion ratings during conditions of the laboratory paradigm that present emotional stimuli (i.e., reappraise, distract, and react-negative conditions) will be significant independent predictors of youth internalizing symptoms. Specifically, higher levels of stress, lower levels of secondary control coping, and higher negative emotion ratings during the reappraisal, distraction, and react conditions of the laboratory paradigm will predict lower levels of internalizing symptoms.

CHAPTER II

METHOD

Participants

The sample included 56 youth and their parents. Youth ranged from age 9 to 15 years old

(M= 12.29, SD = 1.71; 59.6% female). The sample of youth was 68.4% Euro-American, 17.5%

African American, 3.5% Asian, and 1.8% identified as more than one race. The sample of youth

was predominantly non-Hispanic (89.5%). Of parents, the sample was predominantly mothers

(84.2%). The sample of parents had a similar racial and ethnic breakdown, with 68.4% of parents

identifying as Euro-American, 17.5% African American, 3.5% Asian, 1.8% as more than one

race; 91.2% of parents identified as non-Hispanic.

Procedure

Participants were invited to participate in a study designed to better understand how

youth cope with stress in the family. Participants were recruited between June 2016 and April

2017 through a variety of sources, including emails to the Vanderbilt employee list serve,

Vanderbilt Research Match, the Vanderbilt Kennedy Center study finder, and through

participation in a randomized control trial for parents with a history of depression and their

children (R01 MH100258; Co-PIs: Compas and Garber). Interested participants were screened

prior to study enrollment for exclusion based on prior diagnoses of substance abuse,

schizophrenia, bipolar disorder, and intellectual disability. Prior to the lab visit, parents and

children completed a battery of measures through RedCap about stress, coping, and

psychopathology (see Measures below).

During the lab visit, youth completed the laboratory coping and emotion regulation task.

While completing the task, participants also completed a brain scan using functional Near

Infrared Spectroscopy (NIRS). Lastly, youth also completed a measure of cognitive functioning

during the lab visit. The Institutional Review Board at Vanderbilt University approved all procedures. Families were compensated $40 in total for the assessment ($10 for the parent, $30 for the child).

Measures

      Coping and emotion regulation. Parents and their children completed the family stress version of the Responses to Stress Questionnaire (RSQ; Connor-Smith et al., 2000), a questionnaire measure of youth family stress and how youth cope with and regulate their emotions in response to this stress. The RSQ includes 12 items assessing stress associated with family stress and 57 items assessing how often the youth engaged in or enacted specific coping responses in response to family stress in the past 6 months. The RSQ provides scores for mean level of family stress, three coping and emotion regulation scales, and two stress reactivity scales. A five-factor model on the ways in which youths cope with and regulation emotions in response to stress has been established and supported by confirmatory factor analyses across diverse samples of adolescents reporting on a wide range of stressors (e.g., Benson et al., 2011; Compas et al., 2006; Connor-Smith et al., 2000; Wadsworth et al., 2004; Yao et al., 2010). They are divided into three coping scales: primary control coping (i.e., problem solving, emotional expression, emotional modulation), secondary control coping (i.e., cognitive restructuring, positive thinking, acceptance, distraction), disengagement coping (i.e., avoidance, denial, wishful thinking); and two stress reactivity scales: involuntary engagement and involuntary disengagement. The RSQ has demonstrated excellent reliability and validity (Connor-Smith et al. 2000). Notably, the RSQ has also demonstrated associations with laboratory and biological measures, including glycemic control (Jaser et al., 2012) and heart rate responses during a stress task (Connor-Smith et al., 2000; Dufton, Dunn, Slosky, & Compas, 2011).

Analyses in the present study focused on youth self-reports of levels of family stress and secondary control coping in response to family stress. Total family stress scores and proportion scores for secondary control coping were used in analyses. Proportion scores were calculated by dividing the total score for a factor (e.g., secondary control coping) by the total score on the measure (e.g., Osowiecki & Compas, 1998, 1999; Vitaliano et al., 1987) and were used to control for response bias and individual differences in base rates of item endorsement.

Laboratory paradigm. Youth completed a novel laboratory assessment of coping and emotion regulation. The laboratory paradigm was designed to depict stress in the family, in particular stress associated with parental depression, including parental displays of sadness and irritability. In order to identify images for the paradigm, an extensive Internet search process was conducted to identify images that depict stressors associated with parental sadness, irritability, and marital discord using Google Image search engine. In addition, a search was conducted for a diverse sample of images with regard to parental race and ethnicity to match the expected enrollment based on census data from the Middle Tennessee region. In total, over 200 images were initially identified displaying parental sadness,irritability/anger, or marital discord.

To determine if the stimuli depicted negative emotions and evoked negative emotions upon viewing, pilot data were collected from 40 Vanderbilt undergraduate students through a protocol rating images of parental sadness, anger, and marital discord, as well as images of adults displaying happy or neutral facial expressions. Undergraduates rated images on two levels: (1) the degree to which participants felt negative emotions upon viewing the image and (2) the degree to which participants thought the image displayed negative emotion. Pilot ratings made by undergraduates for the degree to which the image displayed negative emotion were used to select the images included in the final task. Images with average ratings of 3 or higher on the

degree to which the image evoked overall negative affect in the participant on a 1 (none) to 5 (a lot) Likert scale were considered for inclusion in the task. Seventy-five images met this criterion, and from these images, 45 images (15 sad, 15 mad, and 15 marital discord) were selected. As a manipulation check, no images depicting happy faces were scored on average a 3 or higher during the image selection phase. However, images depicting neutral faces were variable in the degree to which they evoked negative emotions in the participants. Therefore, a separate set of neutral images of common household objects was selected from the IAPS (e.g., a spoon, desk, lamp) for use in the task. In order to minimize the length of the task and optimize the amount of time participants will view the images during the task, the final task includes 30 images depicting parental sadness (15) and anger (15) found through the methods described above and 10 neutral images selected from the IAPS (images related to marital discord were not included).

The final task used in the current study required youth to view images of adults that look sad or mad and rate their own negative emotion after each image was presented. Youth were asked to imagine that the adult in the image was their parent, and that their parent was feeling sad or angry. The task included four conditions: three conditions included images of adults displaying emotions (reappraisal, distraction, and react-negative; see *Figure 2*) and one condition included neutral pictures (react-neutral). In the reappraisal condition, youth were instructed to reappraise the image to make it *less* stressful/negative or *more* positive (e.g., think, "My mom is just having bad day, she won't be sad forever" when viewing the image). Participants saw the words "Make Positive" on the screen for 1 second prior to the stimulus presentation to remind youth to use reappraisal while viewing the image. In the distraction condition, youth were instructed to think about something *else* that makes them feel good instead of the image to make it *less* stressful or negative (e.g., think about the last time they went on a vacation with their

family when viewing the image). Participants saw the words, "Distract Yourself" on the screen prior to stimulus presentation to remind youth to use distraction while viewing the image. In the react conditions (react-negative and react-neutral), youth were instructed to look at the image as they normally would and the words, "Just Look" were presented prior to the stimulus presentation.

The task included three levels of randomization: (1) order of condition (reappraisal, distraction, react-negative, react-neutral), (2) order of presentation of blocks of sad vs. mad images in the three negative image conditions, and (3) specific images presented within each condition. All youth completed the four task conditions (reappraisal, distraction, react-negative, react-neutral) and were presented with a total of 40 images (i.e., 10 images presented in each of four conditions) drawing from 15 images of adults appearing sad, 15 images of adults appearing mad, and 10 images of neutral objects.

In each condition, instructions were presented on the computer screen and read aloud to participants by the examiner. After instructions for a specific condition were presented, a practice image was presented for 10 seconds. After the practice image was presented, the examiner asked the youth what they were thinking while viewing the image and recorded youth responses on paper. In the reappraisal and distraction conditions, youth were given feedback about their reappraisal or distraction thought; the goal of this feedback was to praise participants for correctly using the specified strategy or to help them understand how to use distraction or reappraisal. Feedback was limited to prompting the child to make a reappraisal or identify a distraction thought up to 2 times following the practice image. Within each condition, after the practice was completed, youth saw a series of 10 images (5 sad and 5 mad); the task instruction (i.e., Make Positive, Distract Yourself, Just Look) was presented for 1 second followed by the

image presentation for 10 seconds. After each image, youth rated their negative emotion on a scale from 1 (not at all) to 5 (very negative). This was repeated for each of the 10 images within each condition. In total, the task was approximately 25-30 minutes in length. Mean negative emotion ratings during each of the four conditions of the task (reappraisal, distraction, react-negative, react-neutral) were used in analyses. In addition, mean negative emotion ratings during the trials with sad images and mad images were calculated separately within each condition and used in analyses.

Brain activation. While completing the coping and emotion regulation task, youth completed a NIRS scan. NIRS is a non-invasive method that uses the degree of hemoglobin oxygenation through the intact skull to infer brain activation in a measured region (Ye, Tak, Jang, Jung, & Jang, 2009). NIRS offers comparable motion tolerance to fMRI in a noiseless environment, with increased comfort and compatibility, making the imaging technique an ideal candidate for imaging children and adolescents. Studies have shown that the signal measured by NIRS is highly correlated with fMRI BOLD signal (Steinbrink et al., 2006). In addition, a number of studies have used NIRS to assess brain activation in the prefrontal cortex in response to cognitive tasks with an emotional component and have detected differences in activation using a variety of cognitive emotion tasks (Bendall, Eachus, & Thompson, 2016).

NIRS was performed with a 24-channel Hitachi ETG-4000 spectrometer to record relative changes of cortical oxy and deoxy-Hb concentrations using a 3x5 probeset consisting of 8 emitters and 7 detectors (interoptode distance=30mm; light penetration=20mm; sampling rate=10Hz). Emitters consist of two laser diodes (3mW ± 0.15mW) with wavelengths of 695 nm and 830 nm that are amplitude modulated (0.6 and 1.5 KHz). We used the international 10-20 system of EEG electrode placement guideline; however, a crucial difference is that NIRS

optodes are held in a fixed holder. Despite anatomical variations among individuals, this method assures standardization across both individuals and time, with right side probes covering Fp2, F4 and F8 and left side probes covering Fp1, F5 and F7. The coping and emotion regulation task was expected to activate prefrontal regions targeted by this NIRS configuration.

Youth symptoms of anxiety and depression. To assess internalizing problems in youth, youth completed the Youth Self Report (YSR; Achenbach & Rescorla, 2001), the self-report version of the CBCL for adolescents 11–18 years of age. The YSR includes a 118-item checklist of problem behaviors during the previous 6 months that youth rate as not true (0), somewhat or sometimes true (1), or very true or often true (2) of their child in the past 6 months. Reliability and validity of the YSR is well established. Children who were 9 or 10 years of age completed the YSR to allow for complete data on all measures (previous studies have shown the YSR is reliable with 9 and 10 year olds; e.g., Fear et al., 2009). Data are reported as normalized *T* scores, based on separate norms for age and sex. The current study used the Mixed Anxious/Depressed syndrome scale to assess youth symptoms of anxiety and depression.

Data Analytic Approach

Means and standard deviations for negative emotion ratings during the four laboratory conditions were examined. The average negative emotion rating across the 10 images presented within a single condition was examined, as well as the average emotion rating across the five sad and five mad images presented as a block within the three emotional conditions. Paired-samples *t*-tests were examined to determine whether emotion ratings differed as a function of task condition. Comparisons between overall emotion ratings by instruction condition (i.e., distraction vs. reappraisal) were conducted. Further, comparisons between emotion ratings in for blocks of sad and mad images within a condition were examined (i.e., reappraisal – sad images vs.

distraction – sad images). In addition, means and standard deviations for youth self-report measures of coping and emotion regulation and symptoms were examined.

Bivariate correlations among negative emotion ratings during the laboratory task, levels of family stress, secondary control coping in response to family stress, and internalizing symptoms are presented in Table 3. Linear regression analyses were conducted to examine whether self-reported levels of stress, coping and emotion regulation, and negative emotion ratings during the laboratory task were significant predictors of symptoms in youth (see Table 5).

NIRS. NIRS data pre-processing was done using a combination of in-house code from Vanderbilt University Institute of Imaging Science XNAT (Harrigan et al., 2016; http://www.nitrc.org/projects/masimatlab) and portions of code from NIRS-SPM (Ye, Tak, Jang, Jung, & Jang, 2009). Data was visually inspected for motion and the spline filtering method was utilized to reduce movement artifacts and increase signal quality (adapted from Scholkmann, Spichtig, Muehlemann, & Wolf, 2010; and Cooper et al., 2012). Cardiac signal strength across channels for each participant was examined as an additional quality parameter (adapted from Pollonini et al., 2014). The modified Beer-Lambert law (Cope et al., 1998; Kocsis et al., 2016) was applied to calculate changes in oxygenated and deoxygenated hemoglobin concentration for each channel in each condition. Oxy and de-oxy concentrations were projected into 3D voxel space, and HbO was used in the current study analyses. We obtained a sense volume of voxels from our optode array, and the sense volume was used as an explicit mask during first level analyses

When transformed into 3D voxel space, data was treated similarly to fMRI, and SPM12 was utilized to conduct first-level analyses. Separate regressors were constructed for the task conditions of interest, and contrast images for single regressors against the baseline were

calculated for each subject using a block-related design specifying the task conditions as regressors of interest. Contrast images for single regressors against the baseline were calculated for each subject (reappraisal, distraction, react-negative, react-neutral).

Contrast images were then submitted to a second level group analyses utilizing SnPM13 within MATLAB 2016b. A statistical parametric map was created for each primary task condition compared to baseline (reappraisal, distraction, react-negative, react-neutral). Additional contrasts were generated for between condition comparisons for those conditions with emotional stimuli (react-negative vs. reappraisal; react-negative vs. distract; reappraise vs. distract). A random-effect second-level analyses was calculated for each condition, and results were calculated in the positive direction for each contrast (condition – baseline) at a corrected voxel threshold of $p = .05$ using the family-wise error correction and a cluster threshold of $p < .05$ using Monte Carlo permutations with 5000 iterations. The cluster-threshold method was applied to control for overall type I error; this method identifies statistically significant clusters based on the number of contiguous voxels whose voxel-wise statistic values are above a selected threshold. Cluster-extent based thresholding has relatively high sensitivity, but lacks spatial specificity (see Woo et al., 2014).

Missing data. Three youth did not complete the laboratory coping and emotion regulation task due to distress related to wearing the cap for the fNIRS scan, and therefore were not included in analyses. One youth selected '1' for every emotion rating during the task and behaviorally did not engage in the task (i.e., kept finger on the '1' button the entire task and frequently looked away from the screen or closed eyes during the task); data from this participant was also not included in the present analyses.

CHAPTER III

RESULTS

Sample characteristics. Mean levels of youth symptoms of anxiety and depression were in the average range (mean *T* score = 57). Only four youth scored in the borderline or clinical range on symptoms of mixed anxiety/depression (*T* score ≥ 67). That is, while youth were on average reporting anxiety/depressive symptoms one half of a standard deviation above the mean, youth were on average not reporting clinically significant levels of symptoms in the current sample. In addition, youth reported moderate levels of family stress (*M* = 11.93, SD = 6.37, range = 0 to 31) in the prior 6 months. Mean family stress scores indicate that the stress depicted in the laboratory paradigm was relevant to the community sample of youth who completed the study.

Youth self-reported levels of family stress were significantly negatively correlated with secondary control coping (*r* = -.29, *p* = .05). Consistent with prior research, youth secondary control coping in response to family stress was significantly negatively correlated with youth mixed anxiety/depression symptoms (*r* = -.41, *p* = .003). As such, greater use of secondary control coping strategies was associated with lower levels of stress and symptoms. In addition, youth self-reported levels of family stress were significantly positively correlated with youth mixed anxiety/depression symptoms (*r* = .60, *p* < .001).

Aim 1. Mean emotion ratings during the laboratory paradigm are presented in Table 2. Paired-samples *t*-tests indicate that on average youth reported higher levels of negative emotion during the react-negative condition (*M* = 2.89) as compared to the react-neutral condition (*M* = 1.24), *t*(55)= 12.86, *p* < .001. That is, youth rated their negative emotion higher when viewing emotional images compared to non-emotional images in the laboratory task.

Comparisons between conditions with emotional stimuli indicate that youth reported lower negative emotion on average when instructed to use secondary control coping strategies compared to react to the stimuli. Specifically, youth average emotion ratings during the reappraisal condition ($M = 2.32$) were significantly lower than emotion ratings during the react condition ($M = 2.89$), $t(55) = -4.68$, $p < .00$). Similarly, average emotion ratings during the distraction condition ($M = 2.17$) were significantly lower than during the react condition ($M = 2.89$), $t(55) = -5.46$, $p < .001$. Average emotion ratings were not significantly different for reappraisal ($M = 2.32$) and distraction ($M = 2.17$) conditions, $t(55) = 1.42$, $p = .16$.

When examining the use of distraction and reappraisal in response to specific emotional images (i.e., sad vs. mad images), a similar pattern emerged. Namely, negative emotion ratings were significantly lower in reappraisal trials ($M = 2.26$) compared to react trials ($M = 2.90$) when viewing sad images ($t(55) = -4.76$, $p < .001$). Negative emotion ratings were also significantly lower during reappraisal trials ($M = 2.34$) compared to react trials ($M = 2.87$) when viewing mad images ($t(55) = -3.96$, $p < .001$). Similarly, negative emotion ratings were significantly lower in distraction trials ($M = 2.23$) compared to react trials ($M = 2.90$) when examining sad images, ($t(55) = -4.59$, $p < .001$). Lastly, negative emotion ratings were significantly lower during distract distraction trials ($M = 2.10$) compared to react trials ($M = 2.87$) when viewing mad images ($t(55) = -5.30$, $p < .001$). In addition, negative emotion ratings were not significantly different between the reappraisal and distraction conditions when viewing sad, $t(55) = .23$, $p = .82$, or mad, $t(55) = 1.64$, $p = .10$, images.

Bivariate correlations were conducted to examine associations between emotion ratings among task conditions (see Table 3). Average emotion ratings during distraction and reappraisal trials were significantly positively correlated ($r = .67$, $p < .001$). Further, average emotion ratings

during distraction and reappraisal trials were also both positively correlated with emotion ratings during the react-negative (r = .54 and .56, respectively, p < .001). Lastly, average emotion ratings during the reappraisal condition (but not distraction) were also positively significantly correlated with emotion ratings during the react-neutral trials (r = .30, p = .02).

Aim 2. One-sample t-tests were conducted using SnPM in MATLAB 2016b to examine whether the percent change in activation differed in each condition (react-negative, react-neutral, reappraise, distract) compared to change in activation during the baseline period (i.e., when viewing a white screen with a black fixation cross) (see Table 4). In all four conditions, there was significant difference between the change in oxygenated hemoglobin during the presentation of stimuli (both emotional and neutral) compared to change in oxygenated hemoglobin during baseline/rest (see Figures 3a-3d). For the reappraise compared to baseline contrast, findings indicate significantly greater activation change during reappraisal (overall cluster significance: p_{FEW} = .007, k = 4134; MNI coordinates: 0, 51, 45, T – 3.99, right BA 9; MNI: 21, 51, 45, T= 3.66; MNI: -51, 12, 39, T = 3.39). Similarly, results showed higher levels of change in activation during distract trials (overall cluster significance: p_{FEW} = .001, k = 4134; MNI: -12, 42, 54, T = 5.02, left BA8; MNI: -36, 18, 60, T = 4.64; MNI: 3, 9, 63, T = 3.98, right BA6). There was significant activation during react-negative compared to baseline trials (overall cluster significance: p_{FEW} = .022, k = 3905; MNI: 0, 51, 45, T = 3.92, right BA9; MNI: -21, 51, 42, T = 3.92; MNI: -12, 60, 39, T = 3.55). Lastly, there was a significant difference identified in the contrast between react-neutral and baseline activation (p_{FEW} = .03, k = 2776; MNI: -39, 18, 57, T = 2.62; MNI: -12, 42, 54, T = 2.59, left BA8; MNI: -3, 30, 60, T = 2.37, left BA8).

However, contrary to hypotheses, there were no significant clusters identified for contrasts comparing task conditions with emotional stimuli (i.e., reappraise vs. react-negative, distract vs. react-negative, reappraise vs. distract contrasts).

Aim 3. Consistent with hypotheses, level of family stress was significantly positively correlated with negative emotion ratings during the distraction condition of the laboratory paradigm ($r = .30, p = .04$). Contrary to hypotheses, perceived family stress was not associated with average emotion ratings during the reappraisal condition. However, the correlation between levels of family stress and negative emotion ratings during the reappraisal condition when mad images were presented approached significance ($r = .26, p = .08$). Similarly, levels of family stress were not significantly correlated with average emotion ratings during the react-negative condition. However, the correlation between stress and negative emotion ratings during the react-negative trials when mad images were presented was significant ($r = .40, p = .006$). Stress was also not significantly associated with negative emotion ratings during the react-neutral condition.

As hypothesized, youth secondary control coping reported on the RSQ was significantly negatively correlated with the average negative emotion rating during distraction trials ($r = -.33$, $p = .02$). That is, higher reports of the use of secondary control coping strategies in response to family stress were associated with lower levels of negative emotion during trials in which youth were instructed to use distraction in the laboratory task. However, contrary to hypotheses, secondary control coping was not significantly correlated with the average emotion rating during reappraisal trials. Secondary control coping was also not significantly correlated with emotion ratings during react trials using emotional or non-emotional images.

Aim 4. Contrary to hypotheses, youth mixed anxiety/depression symptoms were not significantly correlated with average negative emotion ratings during any of the laboratory task

conditions. The correlation between youth mixed anxiety/depression symptoms and negative emotion ratings during react trials using neutral images approached significance ($r = .23$, $p < .10$), indicating there was a trend towards a positive association between emotion ratings in response to neutral images and higher levels of anxiety and depressive symptoms.

Aim 5. Linear regression analyses were conducted to assess whether youth self-reported levels of stress, secondary control coping, and negative emotion ratings during the laboratory task were significant predictors of youth mixed anxiety/depression symptoms (Table 5). In the first step of the regression, the total family stress score on the RSQ was entered; in step two, self-reported secondary control coping on the RSQ was entered into the regression; and in step three, average negative emotion rating (reappraisal, distraction, or react-negative condition average) was entered.

In the model including child stress, secondary control coping, and average negative emotion rating on the reappraisal trials, as hypothesized both stress ($\beta = .55$, $p < .001$) and secondary control coping ($\beta = -.28$, $p = .03$) were significant independent predictors of mixed anxiety/depression symptoms in youth. Stress and secondary control coping accounted for 39% of variance in youth symptoms of anxiety and depression in the final model. When average negative emotion rating during distraction trials was used in the model, child stress ($\beta = .55$, $p < .001$) and secondary control coping ($\beta = -.30$, $p = .02$) predicted youth mixed anxiety/depression symptoms; stress and secondary control coping accounted for 40% of variance in the final model predicting youth symptoms. Negative emotion ratings during the reappraisal and distraction conditions were not a significant predictor of youth symptoms. When average negative emotion rating during react-negative trials was used in the model, a similar pattern emerged. Child stress ($\beta = .55$, $p < .001$) and secondary control coping ($\beta = -.29$, $p = .03$) predicted youth mixed

anxiety/depression symptoms, but negative emotion ratings during react-negative trials did not predict symptoms. In sum, contrary to hypotheses, emotion ratings when viewing emotional stimuli were not significant independent predictors of youth symptoms of anxiety and depression in multivariate analyses when accounting for levels of family stress and secondary control coping in response to family stress.

CHAPTER IV

DISCUSSION

The current study examined a novel laboratory paradigm to measure coping and emotion regulation skills in children and adolescents. The skills to cope with and regulate emotions in response to stress are central to risk and resilience across development. A large body of research has demonstrated significant associations between questionnaire reports of child and adolescent coping and emotion regulation and symptoms of internalizing and externalizing psychopathology (Compas et al., 2017). Laboratory paradigms assessing the use of specific coping and emotion regulation strategies are important both for examining individuals' ability to use strategies in the moment to reduce negative emotion and for understanding neurobiological mechanisms associated with regulation of emotion. The current study was the first to employ a laboratory coping and emotion regulation task designed to capture children and adolescents' responses to parental emotional distress. In addition, the current study aimed to link the laboratory task to a self-report measure of coping and emotion regulation that was a direct parallel to the images presented during the task in order to understand how laboratory methods do or do not relate to coping and emotion regulation in daily life.

Testing a Novel Laboratory Coping and Emotion Regulation Paradigm

First, the current study demonstrated that a laboratory paradigm designed to depict stress associated with parental distress was able to elicit general negative emotion in youth. As hypothesized, youth reported higher levels of negative affect in response to images depicting parental distress compared to neutral images. Further, the paradigm demonstrated that youth are capable of regulating negative emotion when instructed to use specific regulation strategies. Youth reported lower levels of negative affect when instructed to use reappraisal or distraction

while viewing images portraying parental distress as compared to instructions to attend or react to the images presented. These findings are consistent with prior research in adult samples (e.g., Ochsner et al. 2002, Drabant et al., 2009) and child and adolescent samples (e.g., Dougherty et al., 2015; McRae et al., 2012), suggesting that across development, individuals are able to modulate their negative affect in real time using cognitive reappraisal or distraction in the face of relevant emotional stimuli.

Further, as hypothesized and consistent with prior studies comparing distraction and reappraisal (e.g., McRae et al., 2009), there were no differences in self-reported negative emotion when using distraction compared to reappraisal in response to emotional stimuli. It is noteworthy that many studies of both adults and children and adolescents have included practice or teaching sessions in which participants learn how to use reappraisal or distraction or instruct participants on specifically how to think about the images differently (i.e., 'think the picture is not real' or 'keep a string of letters in your mind') (e.g., Dougherty et al., 2015; McRae et al., 2012; Ochsner et al., 2004). However, in the present study relatively minimal instruction was provided to participants with regard to the use of either distraction or reappraisal. Youth were not provided with an explicit reappraisal or distraction technique to use during the paradigm, but rather were expected to generate their own reappraisal and distraction thoughts for each image presented. Therefore, youth may have tried to generate a new reappraisal or distraction thought for each of the 10 images presented during the two conditions, or youth may have employed the same reappraisal or distraction thought for each image. Further, quality of youths' reappraisal or distraction thoughts were not captured, and as such, youths' use of these skills may have varied greatly between participants.

Further, the task elicited significant changes (increases) in brain activation in the prefrontal cortex during trials in which youth viewed emotional stimuli compared to resting state (baseline) activation. More specifically, significant activation in prefrontal regions was detected across all task conditions that presented youth with emotional stimuli, including regions of Brodmann's areas 6, 8, and 9, as well as during the neutral task condition. Results from the imaging analyses are limited in that there is minimal spatial specificity as to where these differences were occurring in these areas. Brodmann's areas 8 and 9 in the prefrontal cortex have been shown to be linked to executive functioning and working memory, but also are implicated in a broad range of functions including language, motor, and memory (e.g., Kubler, Dixon, & Garavan, 2006). Therefore it is difficult to draw conclusions about brain activation and coping and emotion regulation from these initial NIRS findings. Further, contrary to hypotheses, the current study did not find significant differences in prefrontal activation as a function of task condition. Previous studies in adults have found consistent differences in prefrontal activation when using reappraisal compared to attending to emotional stimuli (e.g., Ochsner et al., 2002, 2004; Drabant et al., 2009; McRae et al., 2008, 2009). Studies with children and adolescents have also found consistent evidence for greater activation in prefrontal regions during reappraisal compared to attending (e.g., Belden et al., 2014, 2015; Dougherty et al., 2015). It is possible that our ability to detect differences in activation between conditions was limited by our use of the NIRS to measure brain activation (i.e., lack of spatial specificity of NIRS) and the statistical methods used to assess group differences (Bendall et al., 2016; Woo et al., 2014).

In addition, the instructions for the task in its entirety required cognitive restructuring of the image in order for the participants to imagine that the person in the image was their parent. Therefore, even during the react trials of the task youth were employing some cognitive

regulation techniques in order to reinterpret the image to be their own caregiver. Thus, differences in levels of brain activation between conditions may have been difficult to detect, and further research is needed to explore differences across both task instructions (i.e., imagine it is your parent vs. viewing pictures of adults without explicit instructions to imagine your parent; reappraisal vs. distraction vs. acceptance) and methods used to capture brain activation (i.e., fMRI vs. NIRS). It is also noteworthy that the average negative emotion ratings in each of the emotional images conditions were highly correlated with one another (all medium effect sizes). This parallels findings across the imaging contrasts, such that levels of activation in regions of the prefrontal cortex were consistent in each of the task conditions viewing emotional images.

Comparing Laboratory and Questionnaire Methods

In partial support of study hypotheses, mean emotion ratings during the distraction trials of the task were significantly correlated with self-reported levels of family stress and secondary control coping on a questionnaire measure (RSQ; Connor-Smith et al., 2000). Lower levels of family stress and higher levels of reported secondary control coping strategies in response to family stress in daily life were associated with lower levels of negative emotion when using distraction in response to stimuli depicting parental distress. However, contrary to hypotheses, negative emotion ratings during the reappraisal trials of the task were not significantly associated with stress or self-reported secondary control coping.

The current study is the first to examine whether a laboratory paradigm that was designed to parallel a questionnaire measure of coping and emotion regulation would demonstrate associations to the questionnaire method (see Compas et al., 2017). Given that both reappraisal and distraction were associated with lower levels of negative affect during the laboratory paradigm, both strategies are arguably effective regulation strategies for youth in the presence of

stressful stimuli. However, it may be that youth use distraction more frequently in their daily lives when managing stress in the family, and therefore the regulation of emotions in real time using distraction is more closely related to their daily experience. The items capturing cognitive reappraisal on the RSQ include: 'I tell myself that things could be worse', 'I tell myself that it doesn't matter, that it isn't a big deal', and 'I think about the things I'm learning from the situation or something good that will come from it'. Items assessing distraction include: 'I think about happy things to take my mind off the problem or how I'm feeling', 'I keep my mind off problems with my family by: [list of activities]', 'I imagine something really fun or exciting happening in my life.' Given that cognitive reappraisal is a more complex strategy than distraction and therefore harder to generate in the moment in the laboratory, it is possible that youths' reappraisal thoughts during the laboratory paradigm did not as closely parallel the three reappraisal items on the RSQ as compared to the three distraction items. Further assessment of the specific ways youth are engaging in distraction and reappraisal during the laboratory paradigm may be beneficial in future research to better understand associations with questionnaire methods.

Notably, however, emotion ratings during the reappraisal or distraction conditions of the laboratory paradigm were not significantly correlated with self-reported anxiety and depression symptoms in youth. At the individual strategy level, questionnaire methods have failed to show consistent associations between internalizing symptoms and specific strategies when measured distinctly rather than within a factor of related strategies (Compas et al., 2017). Most relevant to the current study, the effect sizes for the association of cognitive reappraisal and distraction with internalizing symptoms were both non-significant in this meta-analysis (Compas et al., 2017). Findings from the current study suggest that the momentary regulation of emotion, which may

rely on the use of a specific strategy, differs from the use of a larger set of skills to cope with the same stressor or type of stressors over time (as measured by the RSQ).

Strengths and limitations. The current study has several strengths. First, the current study employed multiple methods to examine the use of secondary control coping in youth in response to family stress. Second, the current study expanded on previous coping and emotion regulation laboratory paradigms in important ways. The paradigm was designed to assess how youth are able to regulate their emotions in response to family stress. The images used in the paradigm depict specifically the experience of seeing a parent distressed, which is representative of some forms of family stress. Previous studies have utilized images that are effective in evoking negative emotion, but have rarely selected images that are directly relevant to daily stressful experiences of participants (see Goldin et al., 2014, for an exception). While general negative stimuli such as those included in the IAPS may offer the opportunity to examine the relative use of regulation strategies in the laboratory, it is difficult to draw parallels to how these strategies are important in the face of negative affect in daily life. In order to continue to understand how momentary regulation of emotion and neural responses to regulation efforts are associated with individuals' real life experiences with stress and emotions, the selection of relevant stimuli is important. Third, the study used a questionnaire measure of youth coping and emotion regulation that paralleled the laboratory task and specifically assessed how youth respond to stress in the family (RSQ-Family Stress Version; Wadsworth & Compas, 2002). Although the questions on the RSQ about family stress reflect more than the experience of seeing a parent distressed, the measure captures parent-specific stressors including youths' experience arguing with their parent(s), parent(s) hassling or nagging you, not spending as much time with your parent(s), or having problems with your parent(s).

The study also had a number of limitations. First, the sample size was relatively small and limited the ability to detect small effects in this sample. Second, the study only examined cross-sectional associations between laboratory and questionnaire reports of coping and emotion regulation; future research examining longitudinal associations among these methods and key study constructs will be important. Goldin et al. (2014) found changes in responses to a laboratory paradigm assessing social evaluative threat in a sample of socially anxious adults undergoing CBT treatment. Findings suggest that in addition to longitudinal analyses of how processes of coping and emotion regulation change over time, examining these processes in the context of intervention studies may be particularly important. Third, the study used NIRS to capture brain activation during the laboratory paradigm rather than fMRI, which has been more often used in previous studies. The use of NIRS does not allow for the examination of activation in regions of the brain implicated in the experience of emotion (e.g., amygdala, anterior cingulate cortex). Further, NIRS as an imaging technique offers limited spatial specificity, and the cluster-extent based thresholding method used in the current study analyses does not allow for inferences regarding where within a specific cluster of activation there may be significant differences (Woo et al., 2014). Lastly, the task designed for an at-risk sample, specifically for youth experiencing high levels of family stress and parental distress; the current sample, though experiencing moderate levels of family stress, was not an at-risk sample of youth. Therefore, associations between self-reported coping and emotion regulation, laboratory responses to the coping and emotion regulation paradigm, and symptoms of anxiety and depression may be different in a higher risk population.

Future directions. Next steps in this research include recruiting an at-risk sample of youth, such as children of depressed parents, in order to better understand how these processes

are associated in youth exposed to higher levels of risk. It will also be important to examine these processes in clinical samples of youth (i.e., children diagnosed with a depressive or anxiety disorder) in order to explore how these processes are impacted by higher levels of internalizing symptoms and determine whether associations differ as a function of risk. In addition, including a condition of the paradigm that captures acceptance, another component of secondary control coping on the RSQ, as well as a condition capturing all of secondary control coping, will allow for a complete comparison of laboratory and questionnaire methods. Further, future research needs to explore variations in task instructions, including whether youth practice prior to completing the task or are given explicit regulation instructions and, as noted above, differences in task instructions with regard to the emotional images (e.g., imagine it is your parent vs. viewing pictures of adults without explicit instructions to imagine your parent). In addition, testing the current paradigm with fMRI imaging methods, as well as other psychophysiological methods of stress reactivity, will be important to further our understanding of the neural underpinnings of coping and emotion regulation. Developmentally, research has shown that executive function skills implicated in the use of cognitive coping strategies (like reappraisal) are developing over the course of middle childhood to late adolescence (Diamond, 2013). Future research will benefit from examining differences in the employment of reappraisal, distraction, and other cognitively demanding coping strategies across periods of child and adolescent development. Lastly, in addition to longitudinal studies to examine the developmental trajectory of these processes, the current paradigm has the potential to assess changes in important process of regulation. Examining a laboratory coping and emotion regulation paradigm over the course of an intervention teaching coping and emotion regulation skills will be an important next step in this research.

Conclusion. Taken together, findings suggest that youth are capable of utilizing distraction and reappraisal strategies to regulate negative affect in response to images of parental distress in a controllable laboratory setting. In addition, behavioral measures of a laboratory coping and emotion regulation paradigm show preliminary associations with self-report methods, indicating that there may be some benefit to assessing these processes using multiple methodologies. Further research is needed to better understand the development and use of coping and emotion regulation skills across childhood and adolescence, as well as how these skills may act as a mechanism of risk or resilience during development. The convergence of laboratory and questionnaire methods to assess specific regulation skills is a promising and indicates the possible clinical utility of experimental coping and emotion regulation paradigms in research.

Table 1. Means and standard deviations.

	Mean	Standard Deviation
Responses to Stress Questionnaire (Youth Report)		
Perceived Family Stress	11.93	6.37
Secondary Control Coping	.25	.05
Laboratory Task Average Emotion Ratings		
Distraction – Sad Images	2.23	1.10
Distraction – Mad Images	2.10	1.15
Distraction – All Negative Images	2.17	.89
Reappraisal – Sad Images	2.26	.95
Reappraisal – Mad Images	2.34	.99
Reappraisal – All Negative Images	2.32	.87
React – Sad Images	2.90	1.11
React – Mad Images	2.87	1.03
React – All Negative Images	2.89	.99
React – Neutral Images	1.24	.41
Symptoms of Anxiety and Depression		
YSR – Internalizing	55.49	8.28
YSR – Mixed Anxiety/Depression	57.00	6.80
PHQ-9 Depression (Parent Self-Report)	3.19	3.66

Table 2. Paired sample t-tests comparing emotion ratings during each task condition.

Average ratings (All trials)	t(55)	p
Reappraise vs. React	4.68	< .001
Distract vs. React	5.45	< .001
Reappraise vs. Distract	1.42	.16
React (Emotional) vs. React (Neutral)	12.86	< .001
Sad images trials		
Reappraise vs. React	-4.76	< .001
Distract vs. React	-4.59	< .001
Reappraise vs. Distract	.23	.82
Mad images trials		
Reappraise vs. React	-3.96	< .001
Distract vs. React	-5.03	< .001
Reappraise vs. Distract	1.66	.10

Table 3. Correlations between measures of coping and emotion regulation, stress, and symptoms.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Family Stress	--												
2 SCC	-.29*	--											
3. Distract – Avg	.30*	-.33*	--										
4. Distract – Sad	.31*	-.25$^+$	.97**	--									
5. Distract – Mad	.27$^+$	-.39**	.97**	.88**	--								
6. Reappraise – Avg	.20	-.18	67**	.69**	.62**	--							
7. Reappraise – Sad	.17	-.21	.69**	.69**	.65**	.81**	--						
8. Reappraise – Mad	.26$^+$	-.16	.56**	.59**	.51**	.92**	.70**	--					
9. React – Avg	.26$^+$	-.23	.56**	.56**	.53**	.54**	.54**	.46**	--				
10. React – Sad	.08	-.16	.51**	.51**	.47**	.47**	.52**	.34**	.93**	--			
11. React – Mad	.40**	-.26$^+$	.54**	.53**	.51**	.54**	.48**	.51**	.92**	.72**	--		
12 React – Neutral	-.15	-.15	.21	.23$^+$	.19	.20*	.36**	.22	.30*	.30*	.24$^+$	--	
13. YSR Anx/Dep	.60***	-.41**	.14	.08	.19	.02	-.02	.07	.00	-08	.09	.23$^+$	--

Note:
SCC = Secondary control coping score on the Responses to Stress Questionnaire. Distract = lab task condition during which youth were instructed to "Distract Yourself" when viewing the image; Reappraise = lab task condition during which youth were instructed to "Make Positive" when viewing the image; React = lab task condition during which youth were instructed to "Just Look" when viewing the image.
$^+$indicates $p < .10$, * = $p < .05$, ** = $p < .01$, *** = $p < .001$

Table 4. Results from group-level contrasts for each task condition and baseline activation.

React-Negative vs. baseline							
cluster-level		voxel-level					
p_{FEW} corrected	k	hemisphere	Brodmann area	MNI coordinates (voxel-level)			voxel (t-value)
.02	3905	right	9	0	51	45	3.92
				-21	51	42	3.56
				-12	60	39	3.55
Reappraisal vs. baseline							
cluster-level		voxel-level					
p_{FEW} corrected	k	hemisphere	Brodmann area	MNI coordinates			voxel (t-value)
.007	4134	right	9	0	51	45	3.99
				21	51	45	3.66
		left	8	-51	12	39	3.39
Distraction vs. baseline							
cluster-level		voxel-level					
p_{FEW} corrected	k	hemisphere	Brodmann area	MNI coordinates			voxel (t-value)
.001	4134	left	8	-12	42	54	5.02
				-36	18	60	4.64
		right	6	3	9	63	3.98
React-Neutral vs. baseline							
cluster-level		voxel-level					
p_{FEW} corrected	k	hemisphere	Brodmann area	MNI coordinates			voxel (t-value)
.03	2776			-39	18	57	2.62
		left	8	-12	42	54	2.59
		left	8	-3	30	60	2.37

Table 5. Linear regression analyses predicting youth mixed anxiety/depressive symptoms.

	DV: YSR Mixed Anxiety/Depression		
	β	t-value	Total R^2
Regression 1: Step 3			.39
Family Stress	.55***	4.02	
Youth Secondary Control Coping	-.27*	-2.14	
Avg. Emotion Rating - **Reappraisal**	-.10	-0.85	
Regression 2: Step 3			.40
Family Stress	.55***	4.41	
Youth Secondary Control Coping	-.31*	-2.35	
Avg. Emotion Rating - **Distraction**	-.14	-1.07	
Regression 3: Step 3			.43
Family Stress	.55***	4.32	
Youth Secondary Control Coping	-.29*	-2.23	
Avg. Emotion Rating – **React (Neg)**	-.10	-.79	

Note: *indicates $p < .05$, ** = $p < .01$, *** = $p < .001$

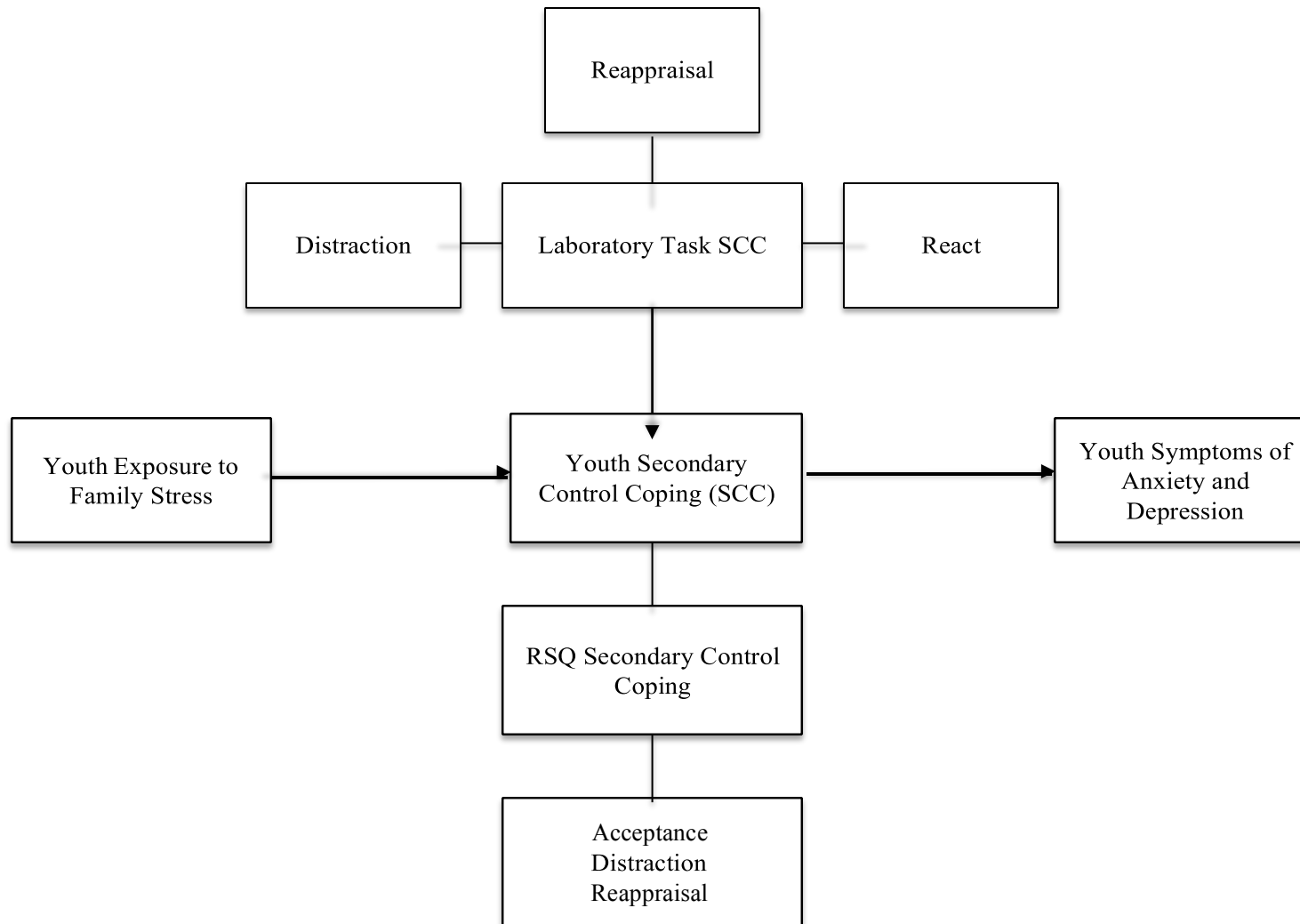*Figure 1.* Heuristic model of the associations among key study variables.

Figure 2. The basic structure of the stimuli presented in the task for the reappraise, distraction, and react conditions.
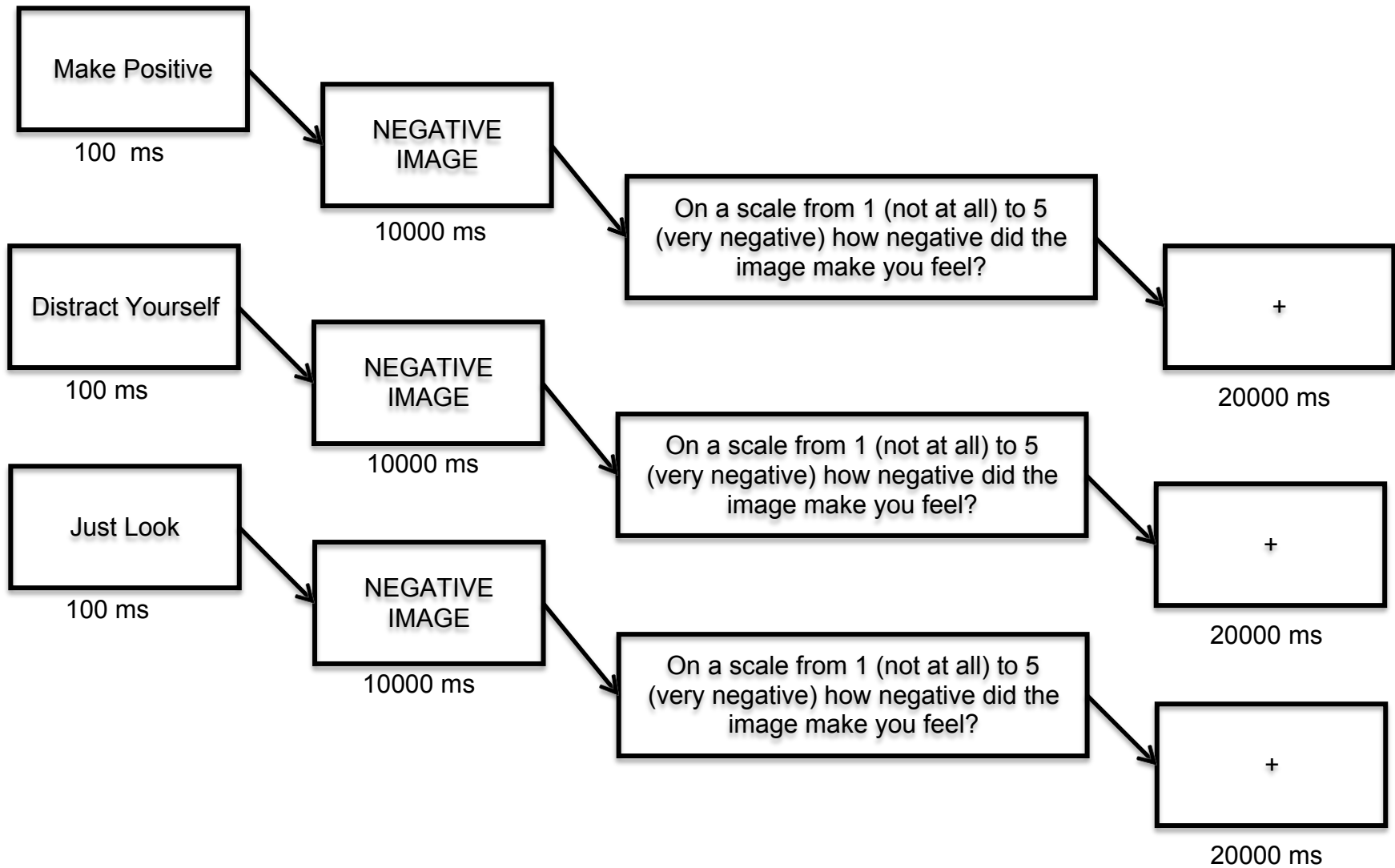

Make Positive

100 ms

NEGATIVE IMAGE

10000 ms

On a scale from 1 (not at all) to 5 (very negative) how negative did the image make you feel?

+

20000 ms

Distract Yourself

100 ms

NEGATIVE IMAGE

10000 ms

On a scale from 1 (not at all) to 5 (very negative) how negative did the image make you feel?

+

20000 ms

Just Look

100 ms

NEGATIVE IMAGE

10000 ms

On a scale from 1 (not at all) to 5 (very negative) how negative did the image make you feel?

+

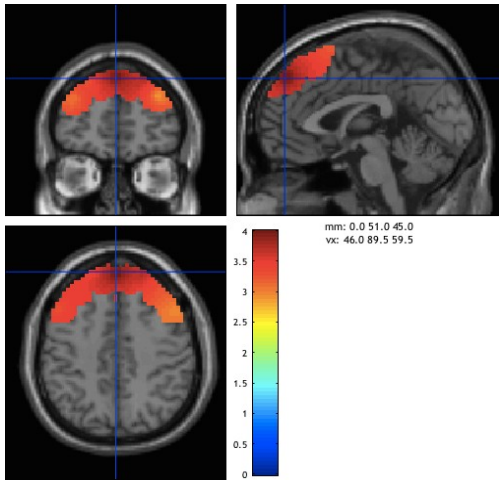20000 ms

Figure 3a. Reappraisal vs. baseline (rest).

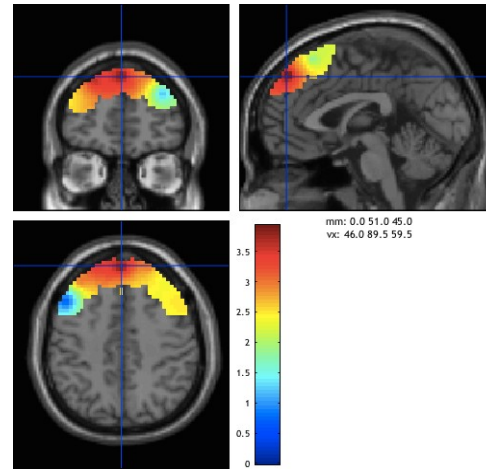Figure 3c. React (Negative) vs. baseline (rest).

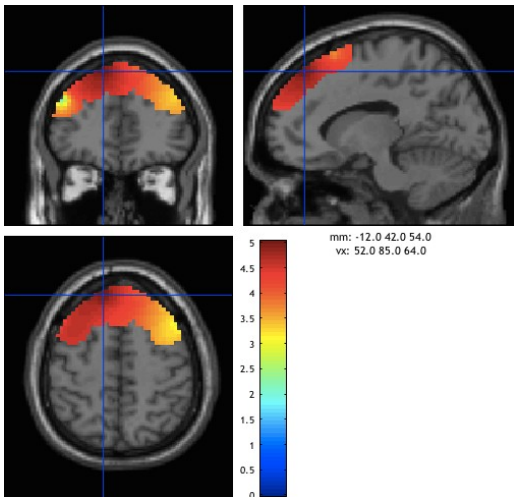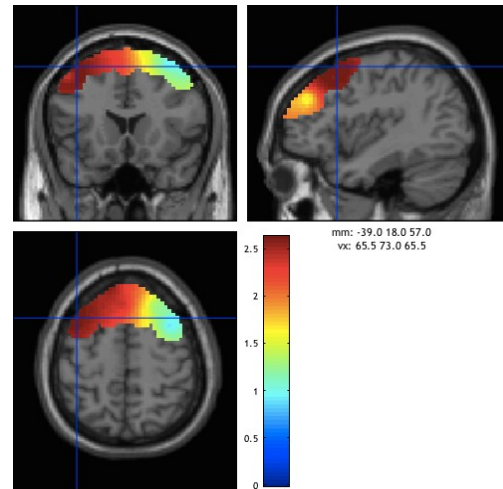Figure 3b. Distract vs. baseline (rest).

Figure 3d. React (Neutral) vs. baseline (rest).

Figures 3a-3d. Contrasts (T values) of change in oxygenated hemoglobin for each condition compared to baseline (resting activation).

BIBLIOGRAPHY

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the Achenbach system of empirically based assessment school-age forms profiles*. Burlington, VT: ASEBA.

Adrian, M., Zeman, J., & Veits, G. (2011). Methodological implications of the affect revolution: A 35-year review of emotion regulation assessment in children. *Journal of Experimental Child Psychology*, *110*, 171-197. doi:10.1016/j.jecp.2011.03.009

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*, 217-237. doi:10.1016/j.cpr.2009.11.004

Andreotti, C., Thigpen, J.E., Dunn, M.J., Watson, K.H., Potts, J., Reising, M.M., Robinson, K.E., Rodriguez, E.M., Roubinov, D.M., Luecken, L. & Compas, B.E. (2013). Cognitive reappraisal and secondary control coping: Associations with working memory, positive and negative affect, and symptoms of anxiety/depression. *Anxiety, Stress and Coping, 26*, 20-35.

Belden, A. C., Luby, J. L., Pagliaccio, D., & Barch, D. M. (2014). Neural activation associated with cognitive regulation of sadness in healthy children. *Developmental Cognitive Neuroscience, 9*, 136-147. http://dx.doi.org/10.1016/j.dcn.2014.02.003

Belden, A. C., Pagliaccio, D., Murphy, E. R., Luby, J. L., & Barch, D. M. (2015). Neural activation during cognitive emotion regulation in previously depressed compared to healthy children: Evidence of specific alterations. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*(9), 771-781.

Bendall, R. C. A., Eachus, P., & Thompson, C. (2016). A brief review of research using near-infrared spectroscopy to measure activation of the prefrontal cortex during emotional

processing: The importance of experimental design. *Frontiers in Human Neuroscience, 10*, 7.

Benson, M. A., Compas, B. E., Layne, C. M., Vandergrift, N., Pašalić, H., Katalinksi, R., & Pynoos, R. S. (2011). Measurement of post-war coping and stress responses: A study of Bosnian adolescents. *Journal of Applied Developmental Psychology, 32*, 323-335. doi:10.1016/j.appdev.2011.07.001

Bettis, A., Forehand, R., McKee, L., Dunbar, J. P., Watson, K. H., & Compas, B. E. (2016). Testing specificity of associations of stress and coping with symptoms of anxiety and depression in children of depressed parents. *Journal of Child and Family Studies*, doi: http://dx.doi.org/10.1007/s10826-015-0270-z

Compas, B. E., Boyer, M. C., Stanger, C., Colletti, R. B., Thomsen, A. H., Dufton, L. M., & Cole, D. A. (2006). Latent variable analysis of coping, anxiety/depression, and somatic symptoms in adolescents with chronic pain. *Journal of Consulting and Clinical Psychology, 74*, 1132-1142. doi:10.1037/0022-006X.74.6.1132

Compas, B. E., Champion, J. E., Forehand, R., Cole, D. A., Reeslund, K. L., Fear, J., … & Merchant, M. J. (2010). Coping and parenting: Mediators of 12-month outcomes of a family group cognitive–behavioral preventive intervention with families of depressed parents. *Journal of Consulting and Clinical Psychology, 78*, 623-634. doi: 10.1037/a0020459

Compas, B. E., Connor-Smith, J. K., Saltzman, H., Thomsen, A. H., & Wadsworth, M. (2001). Coping with stress during childhood and adolescence: Problems, progress, and potential in theory and research. *Psychological Bulletin*, *127*, 87–127. doi:10.1037/0033-2909.127.1.87

Compas, B.E., Gruhn, M., & Bettis, A.H. (2016). Risk and resilience in child and adolescent psychopathology. In T.P. Beauchaine & S. Hinshaw (eds.), *Child and Adolescent Psychopathology (3rd ed.)*. New York: Wiley.

Compas, B. E., Jaser, S. S., Dunbar, J. P., Watson, K. H., Bettis, A. H., Gruhn, M. A., & Williams, E. K. (2014). Coping and emotion regulation from childhood to early adulthood: Points of convergence and divergence. *Australian Journal of Psychology*, *66*, 71-81. doi:10.1111/ajpy.12043

Compas, B. E., Jaser, S. S., Bettis, A. H., Watson, K. H., Gruhn, M., Dunbar, J. P., Williams, E. K., & Thigpen, J. C. (2017). Coping, emotion regulation, and psychopathology in childhood and adolescence: A meta-analysis and narrative review. *Psychological Bulletin,* in press.

Compas, B. E., Watson, K. H., Reising, M. M., & Dunbar, J. P. (2013). Stress and coping: Transdiagnostic processes in child and adolescent psychopathology. In J. Ehrenrich-May & B. Chu (Eds.), Transdiagnostic mechanisms and treatment approaches of youthpsychopathology (pp. 35–58). New York, NY: Guilford.

Connor-Smith, J. K., & Calvete, E. (2004). Cross-cultural equivalence of coping and involuntary responses to stress in Spain and the United States. *Anxiety, Stress & Coping, 17*, 163-185. doi:10.1080/10615800410001709412

Connor-Smith, J. K., Compas, B. E., Wadsworth, M. E., Thomsen, A. H., & Saltzman, H. (2000). Responses to stress in adolescence: Measurement of coping and involuntary responses to stress. *Journal of Consulting and Clinical Psychology*, *68*, 976–992. doi:10.1037/0022-006X.68.6.976

Cooper, R. J., Selb, J., Gagnon, L., Phillip, D., Schytz, H. W., Iversen, H. K., Ashina, M., &

Boas, D. A. (2012). A systematic comparison of motion articact forrection techniques for

functional near infrared spectroscopy. Frontiers in Neuroscience, 11.

https://doi.org/10.3389/fnins.2012.00147

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135-168.

Dorfel, D., Lamke, J. P., Hummel. F., Wagner, U., Erk, S., & Walter, H. (2014). Common and

differential neural networks of emotion regulation by detachment, reinterpretation,

distraction, and expressive suppression: A comparative fMRI investigation. *NeuroImage,*

298-309. *http://dx.doi.org/10.1016/j.neuroimage.2014.06.051*

Dougherty, L. R., Blankenship, S. L., Spechler, P. A., Padmala, S., & Pessoa, L. (2015). An

fMRI pilot study of cognitive reappraisal in children: Divergent effects on brain and

behavior. *Journal of Psychopathology and Behavioral Assessment, 37*, 634-644. DOI

10.1007/s10862-015-9492-z

Drabant, E. M., McRae, K., Manuck, S. B., Hariri, A. R., & Gross, J. J. (2009). Individual

differences in typical reappraisal use predict amygdala and prefrontal responses.

Biological Psychiatry, 65, 367-373. doi:10.1016/j.biopsych.2008.09.007

Dufton, L. M., Dunn, M. J., Slosky, L. S., & Compas, B. E. (2011). Self-reported and laboratory-

based responses to stress in children with recurrent pain and anxiety. *Journal of Pediatric*

Psychology, 36, 95-105. doi:10.1093/jpepsy/jsq070

Dunbar, J. P., McKee, L., Rakow, A., Watson, K. H., Forehand, R., & Compas, B. E. (2013).

Coping, negative cognitive style and depressive symptoms in children of depressed

parents. *Cognitive Therapy and Research*, 37(1), 18-28. doi: 10.1007/s10608-012-9437-8

Evans, G. W., Li, D., & Whipple, S. S. (2013). Cumulative risk and child

development. *Psychological Bulletin, 139*, 1342–1396. https://doi:10.1037/a0031808

Fear, J. M., Champion, J. E., Reeslund, K. L., Forehand, R., Colletti, C., Roberts, L., & Compas, B. E. (2009). Parental depression and interparental conflict: Children and adolescents' self-blame and coping responses. *Journal of Family Psychology, 23*, 762-766. doi:10.1037/a0016381

Folkman, S., & Moskowitz, J. T. (2004). Coping: Pitfalls and promise. *Annual Review of Psychology, 55*, 745-774. doi:10.1146/annurev.psych.55.090902.141456

Garber J., Clarke G. N., Weersing, V. R., Beardslee, W. R., Brent, D. A., Gladstone, T. R. G., DeBar, L.L., Lynch, F.L., D'Angelo, E., Hollon, S.D., Shamseddeen, W., & Iyengar, S. (2009). Prevention of depression in at-risk adolescents: A randomized controlled trial. *JAMA,* 301(21), 2215-2224. doi:10.1001/jama.2009.788

Goldin, P. R., Maner-Ball, T., Werner, K., Heimberg, R., & Gross, J. J. (2009). Neural mechanisms of cognitive reappraisal of negative self-beliefs in social anxiety disorder. *Biological Psychiatry, 66*, 1091-1099. doi:10.1016/j.biopsych.2009.07.014

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The neural bases of emotion regulation: Reappraisal and suppression of negative emotion. *Biological Psychiatry, 63*, 577-586. doi:10.1016/j.biopsych.2007.05.031

Goldin, P. R., Ziv, M., Jazaieri, H., Weeks, J., Heimberg, R. G., Gross, J. J. (2014). Impact of cognitive-behavioral therapy for social anxiety disorder on the neural bases of emotional reactivity to and regulation of social evaluation. *Behaviour Research and Therapy, 62*, 97-106. doi: http://dx.doi.org/10.1016/j.brat.2014.08.005

Grant, K. E., Compas, B. E., Stuhlmacher, A. F., Thurm, A. E., McMahon, S. D., & Halpert, J. A. (2003). Stressors and child and adolescent psychopathology: Moving from markers to mechanisms of risk. *Psychological Bulletin, 129*, 447-466.

https://doi:10.1037/00332909.129.3.447

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348-362. doi:10.1037/0022-3514.85.2.348

Gross, J.J., & Jazaieri, H. (2014). Emotion, emotion regulation, and psychopathology: An affective science perspective. *Clinical Psychological Science, 2*, 387-401. https://doi.org/10.1177/2167702614536164

Gross, J.J., Sheppes, G., & Urry, H.L. (2011). Taking one's lumps while https://doing the splits: A big tent perspective on emotion generation and emotion regulation. *Cognition & 102 Emotion, 25*, 789-793. https://doi:10.1007/s10608-014-9662-4

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 3–24). New York, NY: Guilford Press.

Harrigan RL, Yvernault BC, Boyd BD, Damon SM, Gibney KD, Conrad BN, Phillips NS, Rogers BP, Gao Y, & Landman BA. (2016). Vanderbilt University Institute of Imaging Science Center for Computational Imaging XNAT: A multimodal data archive and processing environment. *Neuroimage*, 124(Pt B):1097-101. doi: 10.1016/j.neuroimage.2015.05.021

Joormann, J., & Vanderlind, W. M. (2014). Emotion regulation in depression: The role of biased cognition and reduced cognitive control. *Clinical Psychological Science, 2*(4), 402-421. doi:http://dx.doi.org.proxy.library.vanderbilt.edu/10.1177/2167702614536163

Jaser, S. S., Champion, J. E., Dharamsi, K. R., Riesing, M. M., & Compas, B. E. (2011). Coping and positive affect in adolescents of mothers with and without a history of depression. *Journal of Child and Family Studies, 20*, 353-360. doi:10.1007/s10826-010-9399-y

Jaser, S. S., Faulkner, M. S., Whittemore, R., Jeon, S., Murphy, K., Delamater, A., & Gery, M.

    (2012). Coping, self-management, and adaptation in adolescents with Type 1 Diabetes.

    Annals of Behavioral Medicine, 43, 311-319. DOI 10.1007/s12160-012-9343-z

Jaser, S. S., Patel, N., Xu, M., Tamborlane, W. V., & Grey, M. (2016). Stress and coping predicts

    adjustment and glycemic control in adolescents with Type 1 Diabetes. *Annals of*

    Behavioral Medicine, 1-9. https://doi.org/10.1007/s12160-016-9825-5

Kubler, A., Dixon, V., Garavan, H. (2006). Automaticity and re-establishment of executive

    control: An fMRI study. *Journal of Cognitive Neuroscience*, 16(6), 1331-1342.

Lane, R. D., & McRae, K. (2004). Neural substrates of conscious emotional experience: A

    cognitive-neuroscientific perspective. In M. Beauregard (Ed.), *Consciousness, emotional*

    self-regulation and the brain; consciousness, emotional self-regulation and the brain (pp.

    87-122, Chapter xii, 291 Pages) John Benjamins Publishing Company, Amsterdam.

    doi:http://dx.doi.org.proxy.library.vanderbilt.edu/10.1075/aicr.54.06lan

Lang, P.J., Greenwald, M.K., Bradley, M.M., & Hamm, A.O., 1993. Looking at pictures:

    affective, facial, visceral, and behavioral reactions. *Psychophysiology 30 (3)*, 261– 273.

McRae, K., Ochsner, K. N., Mauss, I. B., Gabrieli, J. J. D., & Gross, J. J. (2008). Gender

    differences in emotion regulation: An fMRI study of cognitive reappraisal. *Group*

    Processes & Intergroup Relations, 11(2), 143-162. DOI: 10.1177/1368430207088035

McRae, K., Hughes, B., Chopra, S., Gabrieli, J. D. E., Gross, J. J., & Ochsner, K. N. (2009). The

    neural basis of distraction and reappraisal. *Journal of Cognitive Neuroscience, 22*(2),

    248-262.

McRae, K., Gross, J. J., Weber, J., Robertson, E. R., Sokol-Hessner, P., Ray, R. D., Gabrieli, J.

    D. E., & Ochsner, K. N. (2012). The development of emotion regulation: an fMRI study

of cognitive reappraisal in adolescents and young adults. *SCAN, 7*, 11-22.

doi:10.1093/scan/nsr093

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E. (2002). Rethinking feelings: An

fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience,*

14(8), 1215-1229.

Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D. E., &

Gross, J. J. (2004). For better or for worse: neural systems supporting the cognitive

down- and up-regulation of negative emotion. *Neuroimage, 23*, 483-499.

Osowiecki, D., & Compas, B. E. (1998). Psychological adjustment to cancer: Control beliefs and

coping in adult cancer patients. *Cognitive Therapy and Research, 22*, 483-499.

doi:10.1023/A:1018725716620

Osowiecki, D. M., & Compas, B. E. (1999). A prospective study of coping, perceived control,

and psychological adaptation to breast cancer. *Cognitive Therapy and Research, 23*, 169-

180. doi:10.1023/A:1018779228432

Pollonini, L., Olds, C., Abaya, H., Borfeld, H., Beauchamp, M. S., & Oghalai, J. S. (2014).

Auditory cortex activation to natural speech and simulated cochlear implant speech

measured with functional near-infrared spectroscopy. *Hearing Research, 309*, 84-93. doi:

:10.1016/j.heares.2013.11.007

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social

science research and recommendations on how to control it. *Annual Review of*

Psychology, 63, 539-569. doi:10.1146/annurev-psych-120710-100452

Reising, M. M., Bettis, A. H., Dunbar, J. P., Watson, K. H., Gruhn, M., & Compas, B. E. (2017).

Stress, coping, executive function, and brain activation in adolescent offspring of

depressed parents. *Child Neuropsychology,* 1-19.

Robinson, K.E., Pearson, M.M., Cannistraci, C.J., Anderson, A.W., Kuttesch, J.F., …., & Compas, B.E. (2015). Functional neuroimaging of working memory in survivors of childhood brain tumors and healthy children: Associations with coping and psychosocial outcomes. *Child Neuropsychology, 21,* 779-802.

Scholkmann, F., Spichtig, S., Muehlemann, T., & Wolf, M. (2010). How to detect and reduce movement artifacts in near-infrared imaging using moving standard deviation and spine interpolation. *Physiological Measurement, 31*(5), 649-662. doi: 10.1088/0967-3334/31/5/004

Shields, A., & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. *Developmental Psychology, 33*, 906- 916. https://doi:10.1037/0012-1649.33.6.906

Skinner, E. A., Edge, K., Altman, J., & Sherwood, H. (2003). Searching for the structure of coping: A review and critique of category systems for classifying ways of coping. *Psychological Bulletin, 129*, 216-269. doi:10.1037/0033-2909.129.2.216

Smoski, M. J., Keng, S. L., Schiller, C. E., Minkel, J., & Dichter, G. S. (2013). Neural mechanisms of cognitive reappraisal in remitted major depressive disorder. *Journal of Affective Disorders, 151*, 171-177. http://dx.doi.org/10.1016/j.jad.2013.05.073

Steinbrink, J., Villringer, A., Kempf, F., Haux, D., Boden, S., & Obrig, H. (2006). Illuminating the BOLD signal: Combined fMRI-fNIRS studies. Magnetic Resonance Imaging, 24, 495–505.

Sveinbjornsdottir, S., & Thorsteinsson, E. B. (2014). Psychometric properties of the Measure of Adolescent Coping Strategies (MACS). *Psychology, 5*, 142-147.

doi:10.4236/psych.2014.52022

Thompson-Schill, S., Bedny, M., & Goldberg, R. F. (2005). The frontal lobes and the regulation of mental activity. *Current Opinion in Neurobiology, 15*(2), 219-224. doi:http://dx.doi.org.proxy.library.vanderbilt.edu/10.1016/j.conb.2005.03.006

Vitaliano, P. P., Maiuro, R. D., Russo, J., & Becker, J. (1987). Raw versus relative scores in the assessment of coping strategies. *Journal of Behavioral Medicine, 10*, 1-18. doi:10.1007/BF00845124

Wadsworth, M. E., Rieckmann, T., Benson, M. A., & Compas, B. E. (2004). Coping and responses to stress in Navajo adolescents: Psychometric properties of the Responses to Stress Questionnaire. *Journal of Community Psychology, 32*, 391-411. doi:10.1002/jcop.20008

Wadsworth, M. E., & Compas, B. E. (2002). Coping with family conflict and economic strain: The adolescent perspective. *Journal of Research on Adolescence*, 12, 243-274. https://doi:10.1111/1532-7795.00033

Wager, T. D., & Smith, E. E. (2003). Neuroimaging studies of working memory: A meta-analysis. *Cognitive, Affective & Behavioral Neuroscience, 3(4)*, 255-274. doi:http://dx.doi.org.proxy.library.vanderbilt.edu/10.3758/CABN.3.4.255

Weisz, J. R., McCabe, M. A., & Dennig, M. D. (1994). Primary and secondary control among children undergoing medical procedures: Adjustment as a function of coping style. *Journal of Consulting and Clinical Psychology, 62*, 324-332. doi:10.1037/0022-006X.62.2.324

Woo, C., Krishnan, A., & Wager, T. D. (2014). Cluster-extent based thresholding in fMRI analyses: Pitfalls and recommendations. *Neuroimage, 1*(91), 412-419.

doi:10.1016/j.neuroimage.2013.12.058

Xiao, J., Yao, S., Zhu, X., Zhang, C., Auerbach, R. P., McWhinnie, C. M., & Abela, J. R. Z. (2010). The responses to stress questionnaire: Construct validity and prediction of depressive and social anxiety symptoms in a sample of Chinese adolescents. *Stress and Health: Journal of the International Society for the Investigation of Stress, 26*, 238-249. doi:10.1002/smi.1291

Ye, J. C., Tak, S., Jang, K. E., Jung, J., & Jang, J. (2009). NIRS-SPM: Statistical parametric mapping for near-infrared spectroscopy. *Neuroimage, 44*(2), 428-447.