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The Role of Affective Flexibility and Cognitive Flexibility in Effective Antecedent-Focused and Online Reappraisal

Ashley M. Malooly
University of Miami, amalooly@gmail.com

UNIVERSITY OF MIAMI

THE ROLE OF AFFECTIVE FLEXIBILITY AND COGNITIVE FLEXIBILITY IN EFFECTIVE ANTECEDENT-FOCUSED AND ONLINE REAPPRAISAL

By

Ashley M. Malooly

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Ashley M. Malooly

Approved:

________________ Matthias Siemer, Ph.D. Professor of Psychology	________________ Terri A. Scandura, Ph.D. Dean of the Graduate School
________________ Craig D. Marker, Ph.D. Professor of Psychology	________________ Bonnie E. Levin, Ph.D. Professor of Neurology

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Individuals regulate their emotional experiences on a daily basis, and cognitive reappraisal is one particularly adaptive way to do so. Some evidence suggests that online cognitive reappraisal, which occurs as an emotion-triggering event is unfolding, is also an effective strategy. Several studies have proposed that executive control processes such as working memory, inhibition, and cognitive flexibility carry important implications for emotion regulation. The current study sought to better understand the relationship cognitive reappraisal and one of these executive control processes, cognitive flexibility. Furthermore, this study investigated how flexible processing of affective material, or affective flexibility, was associated with cognitive reappraisal. Participants completed tasks assessing cognitive flexibility, affective flexibility, and reappraisal effectiveness, as well as self-report measures which assessed emotional reactivity, symptoms of depression, and emotional experiences during the reappraisal task. Participants were randomly assigned to receive either antecedent-focused or online reappraisal instructions during the reappraisal task. Surprisingly, results showed that affective flexibility was unrelated to cognitive flexibility. However, a specific component of affective flexibility, assessing switching of mental sets away from an affective mental set and toward a non-affective mental set, predicted emotion regulation outcomes, specifically when participants were categorizing negative images. This relationship remained after controlling for general cognitive flexibility, neuroticism, and depressive symptomatology. Contrary to hypotheses, the timing of reappraisal did not moderate this relationship, suggesting that affective flexibility is equally important for both antecedent-focused and online reappraisal. Implications of these findings and future directions are discussed.

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Chapter 1: Introduction

Emotion Regulation

Imagine that you have just encountered an emotionally-evocative situation – another driver has cut you off on the way to work, or even worse, you have been fired from the job you thought would be your career. Although our first reactions to either of these situations would likely be one or more negative emotions such as frustration, anger, hurt, or sadness, there are things that we can do to change how we respond. Suppose that you thought to yourself that the driver who cut you off is probably late for work and did not mean you any harm – how would this reinterpretation change your emotional response? Or suppose that you reinterpreted being fired from your job as an opportunity for you to reinvent yourself, or to start the business that you've always dreamed of – would this decrease your anger or sadness, or even change your feelings about losing your job?

Every day, we encounter similar events with the potential for eliciting strong emotions. However, we all react to these events in different ways, depending on our interpretations, what aspects of the event we attend to, what else we think about, etc. These heterogeneous strategies that we use to modify our emotional experiences are termed emotion regulation (Gross, 1998; Gross & Thompson, 2007). Emotion regulation refers to both automatic and controlled processes that are used to increase, decrease, or sustain an emotional response (Gross & Thompson, 2007). People may regulate their emotions for several reasons, such as to serve hedonic purposes, to facilitate goal-attainment or performance, or to improve personality functioning (Koole, 2009). For example, remaining sad following termination from a job is likely aversive for most people, so modifying this response may be motivated by the goal of feeling good. Or becoming angry after being cut off by another driver may not be very adaptive if we must continue to share the road with other drivers, so modifying this emotional response may help you to achieve the goal of getting to work in one piece.

As alluded to previously, there are numerous ways to regulate one's emotions, but one particularly powerful method is *reappraisal*. Reappraisal is a cognitive emotion regulation strategy with the goal of changing the way one evaluates a situation in order to change the emotions one experiences (Gross, 1999). People can reappraise, or change the interpretation of a situation, in several different ways, such as by focusing on the non-emotional aspects of the situation, reducing the emotional impact of the situation by imagining that it is not real or staged, or imagining how the situation will change in the future (Gross, 1998; Gross, 1999). Reappraisal is commonly conceptualized as an antecedent-focused strategy, meaning that this form of regulation typically occurs before a full-blown emotional response is experienced, essentially "cutting off" the emotion (Gross, 1998). This is contrasted with response-focused strategies, which intend to directly modify physiological, experiential, or behavioral responding (Gross & Thompson, 2007). Such strategies include behavioral suppression, which intends to modify the on-going behavioral expression of emotion, and exercise and relaxation, which intend to modify physiological and experiential responding (Gross, 1998; Gross & Thompson, 2007).

Antecedent-focused emotion regulation strategies include any strategies which act early on in the emotion generation cycle (Gross & Thompson, 2007). One such strategy, attentional deployment, involves redirecting attention in order to regulate emotional responding. For example, while watching a movie, one may choose to redirect focus away from a crying child and toward less emotional characters in order to reduce feelings of sadness. Distraction is another antecedent-focused emotion regulation strategy, which consists of diverting attention away from the emotional situation entirely and thinking instead about something else. While watching the same movie, one may reduce their sadness with distraction by attempting not to think about the film at all, and instead thinking about something pleasant. Like reappraisal, these strategies involve changing one's thoughts in order to subsequently change emotional experiences. In general, antecedent-focused strategies are quite effective at reducing the subjective, behavioral, and physiological experience of emotions (Gross, 1998; Gross & John, 2003).

On the other hand, response-focused strategies act later in the emotion generation process with the intention of targeting behavioral, experiential, or physiological responding directly. Although many different strategies can be used to directly regulate components of emotional responding, much research on response-focused emotion regulation has focused on behavioral suppression. Behavioral suppression involves attempts to control the expression of an emotion, rather than controlling the experience of an emotion per se. For example, someone may hold back tears or attempt to keep a straight face while watching an upsetting movie. Although behavioral suppression does successfully reduce emotional expression, it does little to reduce the subjective experience of emotion (Gross, 1998). Furthermore, behavioral suppression, exaggerates sympathetic responding because of the exertion of self-control resources (Gross, 1998; Gross & John, 2003).

Reappraisal has been of particular interest in research because of its effectiveness in decreasing the experiential, behavioral, and physiological components of emotional responding (Gross, 1998; Hajcak, Moser, & Simons, 2006; Ray, Wilhelm, & Gross, 2008; Urry, 2010) without negative impact in other domains. For example, response-focused behavioral suppression involves directing attention toward monitoring bodily expression of emotions and requires self-control resources to inhibit responding. Therefore, fewer attentional resources are available to attend to the current situation. As such, behavioral suppression has been associated with difficulties in communication and rapport building in social interactions (Butler et al., 2003). On the other hand, because reappraisal involves a change in mental set rather than an attentional shift, cognitive reappraisal has not been found to significantly impede social interactions (Butler et al., 2003). Further, distraction, an antecedent-focused emotion regulation strategy, involves redirecting attention away from emotional stimuli and toward something more neutral, and thus carries a risk of memory impairment (Richards & Gross, 2006). Behavioral suppression also carries this risk because of the redirection of attention toward the body and away from the situation at hand, as well as the exertion of self-control resources (Gross, 2002). Reappraisal, on the other hand, does not involve the attentional redirection characteristic of other antecedent-focused strategies, and does not seem to consume as many self-control resources as suppression because of its early initiation, suggesting that reappraisal should not be associated with memory impairments. Indeed, studies have shown that although memory for details of film clips is impaired when subjects are asked to distract (Richards & Gross, 2006) or behaviorally suppress (Gross, 2002), memory remains intact when subjects are asked to reappraise (Gross, 2002; Richards & Gross, 2006). Therefore, reappraisal is conceptualized as not only effective, but free of cognitive costs.

Further, the use of reappraisal has been associated with a host of positive outcomes in the research literature. A study conducted by Gross and Oliver (2003) found that individuals who reported habitual reappraisal experience and express more positive emotions and fewer negative emotions according to both self and peer-report, share their emotions more often with others, have closer social relationships, report fewer symptoms of depression, and exhibit better psychological well-being compared with habitual suppressors. Additionally, reappraisal ability has been found to buffer individuals from depression in the face of high stress (Troy, Wilhelm, Shallcross, & Mauss, 2010). In the laboratory, participants instructed to reappraise exhibited improved memory for emotional images compared with both those instructed to suppress their emotions and control participants (Richards & Gross, 2000). Therefore, the current research literature seems to suggest that not only is reappraisal effective in reducing all aspects of emotional experience, it is also beneficial for social and psychological well-being, and may improve attention and memory.

Online Emotion Regulation

Recently, researchers have begun to examine online reappraisal, which refers to reappraisal that occurs while an emotion-triggering event is unfolding (Sheppes & Meiran, 2007). For example, rather than being asked to begin reappraising at the film's outset, a participant may be instructed to begin reappraising 2 minutes into the film. In this case, the emotion generation process has already begun, and reappraisal is used to try to modify an emotional experience that is already occurring. Online reappraisal may be more representative of emotion regulation that occurs in everyday life, given that we typically are not aware of when situations will arise which necessitate emotion regulation.

Online reappraisal has been of particular interest given that reappraisal is very effective as an antecedent-focused strategy, and is not associated with detrimental effects on memory or social interactions (Butler et al., 2003; Gross, 2002). Thus, one might wonder if reappraisal is also effective and without costs if initiated later on in the emotion generating process. Two studies have investigated this very question by instructing participants to begin reappraisal sometime after stimulus onset. Urry (2009) investigated online reappraisal in the context of affective pictures, by instructing participants to begin cognitive reappraisal either 2 seconds before picture onset (antecedent-focused) or 4 seconds after picture onset (online). The results showed that there was no difference in subjective emotional experience based on whether reappraisal was initiated early or online; suggesting that online reappraisal is equally as effective as antecedent-focused reappraisal (Urry, 2009). On the other hand, Sheppes and Meiran (2007) investigated this same research question by presenting participants with a distressing film clip and instructing half of participants to begin reappraisal prior to the film, and the other half to begin reappraisal upon presentation of a cue approximately 2 minutes into the film. When compared with antecedent-focused reappraisal, online reappraisal of sad film clips was found to be less effective at reducing subjective ratings of emotional distress, suggesting that online reappraisal is more difficult than antecedent-focused reappraisal (Sheppes & Meiran, 2007). Although these seem like conflicting results, this difference may reflect the difference in affective stimuli used. It may be more difficult to regulate emotions online regarding a changing stimulus (film clip) compared with a more stable stimulus (affective picture). However, these conflicting results do necessitate further inquiry into our conceptualization of online reappraisal.

To further investigate the process of online reappraisal, Sheppes and Meiran (2008) compared online reappraisal with online distraction. Participants were again presented with a distressing film clip, and all subjects were instructed to begin emotion regulation online; however, half of participants were instructed to reappraise online and the other half were instructed to distract online. Participants then completed a Stroop task to assess depletion of self-control resources, and a memory test to assess memory of the film. Compared with participants who utilized online distraction, participants instructed to reappraise online exhibited a larger Stroop effect, indicating that online reappraisal depleted more self-control resources than online distraction. However, results of the memory test indicated that like antecedent-focused reappraisal, online reappraisal did not negatively affect memory (Sheppes & Meiran, 2008). These results suggest that online reappraisal may be more difficult than antecedent-focused reappraisal because it is more cognitively demanding; however, the exertion of these self-control resources did not impair memory as it does with other emotion regulation strategies such as distraction.

To lend more support to the authors' hypothesis that online reappraisal involves significant self-control resources, Sheppes and colleagues examined online reappraisal and distraction using psychophysiological measures (Sheppes, Catran, & Meiran, 2009). Participants' skin conductance, skin temperature, and heart rate were monitored using physiological sensors while participants viewed a distressing film clip. All participants began viewing the film clip naturally, and then were instructed to reappraise, distract, or continue to view the film normally 3 minutes into the film clip. Both the online reappraisal and online distraction groups reported less negative emotions following the film clip. Further, the reappraisal group exhibited a greater skin conductance response than either the distraction or control groups (Sheppes et al., 2009). The reappraisal group also exhibited a drop in finger temperature, compared with a rise in skin temperature for the distraction and control groups (Sheppes et al., 2009). These physiological changes are both associated with cognitive inhibition, suggesting that online reappraisal, but not distraction, is associated with increased self-regulation.

In sum, the literature seems to indicate that although online reappraisal may not be quite as effective as antecedent-focused reappraisal, it is still an effective emotion regulation strategy (Sheppes & Meiran, 2007; Urry, 2009). Online reappraisal is likely more difficult than antecedent-focused reappraisal because it drains self-regulatory resources; whereas antecedent-focused reappraisal does not (Sheppes & Meiran, 2008; Sheppes et al., 2009). However, although online reappraisal requires self-control resources, using this strategy is not associated with the memory deficits characteristic of other strategies such as distraction (Sheppes & Meiran, 2008). These findings suggest that when faced with an unfolding emotional situation, online reappraisal may be an adaptive strategy to use. Given the potential benefits associated with using online reappraisal, the mechanisms which promote successful emotion regulation, particularly successful reappraisal, deserve attention.

Neuropsychology of Emotion Regulation

Neuropsychological studies with both healthy individuals and with clinical patients point to the importance of the frontal lobe in regulating emotions. To examine which areas of the brain are activated during cognitive reappraisal, Ochsner, Bunge, Gross, and Gabrieli (2002) used fMRI to monitor healthy participants' brain activity while they were presented with negative photos and instructed to either attend to the photo or reappraise in order to no longer feel negatively about the photo. To determine which areas were important for reappraisal, the authors compared the pattern of activation during attend trials and reappraisal trials. This allowed the authors to parse out which areas were associated with emotional processing in general, and to subtract these areas from those which were active during reappraisal trials in order to determine which areas are specifically related to reappraisal. The authors found that, among other areas, reappraisal was associated with activation of the prefrontal cortex, particularly the dorsal and ventral left lateral prefrontal cortex and the dorsal medial prefrontal cortex. Activation of these areas was also associated with decreased activation in the amygdala, suggesting that these regions may play a role in modulating amygdala response to emotional stimuli.

Additional evidence for the role of the frontal cortex in emotion regulation has come from studies of patients with acquired brain injuries. For example, a case study was conducted on a patient with degenerative damage to the inferior frontal gyrus, who exhibited emotional lability and limited voluntary expression of emotion, to determine the nature of the patient's symptoms (Woolley et al., 2004). This patient was asked to watch negative film clips and to either view them normally or to suppress her emotional response. While viewing the negative films normally, the patient appeared comparable to controls in terms of her emotional expression and physiology. However, when asked to suppress her emotional response to the films, the patient on the contrary exhibited increased emotional expression and physiological responding, although she reported that she understood the instruction to suppress her emotions and felt that she was successful. Although limited by its design, this case study lends further evidence for the importance of the frontal lobe in successful emotion regulation.

Other patient populations with frontal lobe damage or dysfunction due to acquired brain injury have also been shown to have characteristic deficits relevant to emotion regulation. Patients with bilateral lesions to the orbitofrontal cortex, for example, have been shown to display elevated antisocial behavior and deficits in appropriate social and emotional functioning, according to both self and informant report measures, which may be related to a difficulty in regulating emotions (Bramham, Morris, Hornak, Bullock, & Polkey, 2009). Frontotemporal lobar degeneration patients have also been shown to exhibit deficits in socioemotional functioning, particularly affective flattening and emotion dysregulation. One study has found that although these patients exhibit emotional reactivity which is comparable to control participants while watching emotionally evocative film clips, they display a deficit in the recognition of negative emotions in these film clips, particularly fear and sadness. Furthermore, these deficits in recognition of negative emotions were found to be associated with the frontal and temporal lobe volumes, such that patients with the lowest frontal and temporal lobe volumes exhibited the poorest emotion recognition (Werner et al., 2007).

Patient populations with frontal lobe damage in addition to more diffuse brain damage, such as patients with Traumatic Brain Injury and Parkinson's disease, have also been shown to exhibit deficits in emotional processing and regulation. For example, patients with Traumatic Brain Injury have been found to exhibit characteristic deficits in the ability to recognize basic emotions in facial expressions, as well as in theory of mind, which involves attributing emotional states to others (e.g. Henry, Phillips, Crawford, Ietswaart, & Summers, 2006). Studies have also shown that Traumatic Brain Injury patients demonstrate loss of emotional control (e.g. aggression, impulsivity) according to informant report from pre-trauma to post-trauma (e.g. Tate, 1999) The majority of patients in both of these studies exhibited frontal lobe damage (Henry, Phillips, Crawford, Ietswaart, & Summers, 2006; Tate, 1999). Patients with Parkinson's disease also exhibit frontal cortex dysfunction due to the death of dopamine producing cells in the substantia nigra. Consistent with this frontal deficiency, Parkinson's patients have been shown to exhibit deficits in emotional stability, as well as in general self-regulation, per patient self-report (e.g. Volpato, Signorini, Meneghello, & Semenza, 2009).

Therefore, based on the results of studies with both healthy controls and neuropsychological patients, it seems that the frontal cortex is essential for appropriate emotional processing and regulation. It is important to note, however, that these same areas are also involved with executive control processes such as working memory and attention, suggesting that the same mechanisms which regulate cognitive processing of thoughts may also regulate cognitive processing of emotions (e.g. Woolley et al., 2004). Therefore, examination of executive control may lend additional information toward understanding the process of effectively regulating emotions.

Executive Function and Cognitive Flexibility

Cognitive processes related to executive function have recently received increased attention with regards to their relationship with emotion regulation. Executive function is a blanket term that refers to a diverse set of higher-order cognitive processes involved in self-regulation and problem solving (e.g. Roberts, Robbins, & Weiskrantz, 1998; Zelazo & Cunningham, 2007). Executive functions can be conceptualized in a hierarchical manner based on the steps necessary to problem-solve (Zelazo, Carter, Reznick, & Frye, 1997). These steps include creating a mental representation of the problem (problem representation), developing a plan to solve the problem (planning), keeping the plan in mind (intending) and executing the plan (rule use), and evaluating the success of the plan (error detection) so that adjustments can be made if needed (correction). Several cognitive processes are implicated in executive function, including self-monitoring, error detection, working memory, response inhibition, and set-shifting (e.g. Roberts et al., 1998). These processes are differentially recruited in order to successfully implement different aspects of executive function. For example, during the intending stage, an individual must use working memory to keep the plan in mind (Zelazo & Cunningham, 2007).

Executive function has also been conceptualized using a Levels of Consciousness Model, which consists of the abstract, problem-solving level described above, as well as a more concrete, implementational level (Zelazo & Cunningham, 2007). The implementational level refers to the activities in the brain needed to implement cognitive processes related to executive function, and considerable research has indicated that the prefrontal cortex and its related connections are essential for successful executive function (Bunge & Zelazo, 2006; Miller, 1999; Zelazo & Cunningham, 2007). Furthermore, different areas of the prefrontal cortex have been associated with different aspects of executive function (Bunge, 2004). For instance, much current research indicates that the prefrontal cortex is involved with rule-driven behavior, but that different areas of the prefrontal cortex are involved with different aspects of rule conceptualization (Bunge & Zelazo, 2006). Whereas responding to simple rules has been associated with orbitofrontal cortex activation, responding to conditional rules has been associated with activation of the ventrolateral and dorsolateral prefrontal cortices, and responding to higher-order rules such as during task-switching has been associated with rostrolateral prefrontal cortex activation (Bunge & Zelazo, 2006).

Importantly, this research informs us that executive function involves the interaction of both bottom-up and top-down processes (Zelazo & Cunningham, 2007). At the more abstract, problem-solving level, executive function acts in a top-down manner. The problem is represented, a plan of action is developed, and the plan is then sent off to be implemented. However, at the implementational level, executive function works in a bottom-up way, with information moving through the PFC in a hierarchical manner, from simple to complex. Notably, these implementational processes are often quite automatic and inflexible, necessitating reflection and flexibility on the part of the top-down processes in order to solve the problem effectively. Therefore, the process of executive function is dynamic and unfolds over time (Zelazo & Cunningham, 2007).

Cognitive Flexibility

One cognitive process which may be particularly important for emotion regulation is cognitive flexibility. Cognitive flexibility is defined as the ability to generate and shift response based on the changing demands of a situation (e.g. Lezak, 1995). For example, if the phone rings while one is writing, one must be able to inhibit a writing schema, switch to a telephone schema, and activate that schema, in order to respond to the new situation. Thus, cognitive flexibility involves several components of executive function, including working memory, response inhibition, and set-shifting.

Although the Wisconsin Card Sorting task is commonly used to assess executive functions, particularly cognitive flexibility, it is a complex task which has been shown to be associated with diffuse fronto-parietal activation (Buchsbaum, Greer, Chang, & Berman, 2005). The task-switching paradigm, on the other hand, seems more specific to cognitive flexibility (e.g. Monsell, 2003) and is associated with a more distinct, bilateral pattern of activation in the fronto-parietal regions as well as the ventrolateral prefrontal cortex (Buchsbaum, Greer, Chang, & Berman, 2005). In the task-switching paradigm, participants are asked to categorize stimuli based on different rules (Monsell, 2003). For example, participants may sort numbers based on whether they are high/ low, or odd/even. The active sorting rule switches at random, such that participants are unsure of which categorization rule will be active during the next trial (Meiran, 1996). Thus, this task requires participants to flexibly switch between different categorization rules or “task-sets” (Meiran, 2000). Task-sets are mental representations that bias the interpretation of bivalent stimuli. For example, if the active rule instructs the participant to categorize a number based on whether it is odd or even, the participant should be biased to focus on whether the number is odd or even and ignore irrelevant information, such as how high or low the number is.

There are two different types of trials in the task-switching paradigm: trials in which the active rule is the same as in the previous trial (repetition trials) and trials in which the active rule is different than in the previous trial (switch trials). Researchers are generally interested in participants’ reaction times during these different trials, and participants' reaction times tend to be higher on switch trials compared with repetition trials (Monsell, 2003). This difference in participants' reaction times between switch trials and repetition trials is conceptualized as a "switch cost," or the additional time needed to make a response because of the need to switch task-sets (Monsell, 2003). Researchers have conceptualized switch costs in different ways, for example, as due to inhibition of carry-over effects from the previous rule (Allport, Styles, & Hsieh, 1994), reconfiguration of mental set or set-switching (Rogers & Monsell, 1995), or a combination of both (Meiran, 1996). However, it is currently believed that switch costs are primarily due to executive control processes related to set-switching, and thus can serve as a measure of cognitive flexibility (Meiran, 1996; Monsell, 2003).

Several neuropsychological patient populations exhibit deficits in measures of executive function, and specifically cognitive flexibility. Patients with frontal lobe lesions are commonly found to exhibit characteristic deficits in cognitive flexibility as assessed with the Wisconsin Card Sorting Task, which requires participants to determine a sorting rule, maintain that rule, and switch to a new rule when the current rule is no longer reinforced (Grattan, Bloomer, Archambault, & Eslinger, 1994; Grattan, & Eslinger, 1989; MacPherson, Phillips, Della Sala, & Cantagallo, 2009). Frontal lobe patients have also been shown to exhibit difficulties with the Alternate Uses Test, which requires participants to generate as many uses as possible for a given object, and assesses flexibility in thought (Grattan, Bloomer, Archambault, & Eslinger, 1994; Grattan, & Eslinger, 1989). Patients with Alzheimer's disease have also been found to exhibit deficits in Stroop task and emotional Stroop task performance, both which require inhibition (Doninger, & Bylsma, 2007). Furthermore, patients with Parkinson's disease

(Volpato, Signorini, Meneghello, & Semenza, 2009) and Traumatic Brain Injury (Rochat, Ammann, Mayer, Annoni, & Van der Linden, 2009; Tate, 1999) have also been found to exhibit deficits in tests of executive function. The fact that these patient populations exhibit both emotion dysregulation and also deficits in executive function suggests that these constructs may be neurologically related to one another.

Executive Function and Emotion Regulation

As described previously, reappraisal involves changing one's evaluation of a situation in order to change one's emotional reaction, for example, by examining the context of the situation (e.g. , imagining it is not real, looking at the bigger picture), or changing the elements of the situation that the person attends to (Gross, 1999). Thus, the definition of reappraisal implies that reappraisal involves a change in mental set, suggesting that cognitive control processes likely play a role in the use of this and other cognitive emotion regulation strategies. Indeed, studies have found that a number of cognitive processes related to executive function contribute to cognitive emotion regulation (Ochsner & Gross, 2005). Executive control processes can be used to regulate emotions directly, such as by elaborating on the details of an emotionally disturbing event in order to decrease its emotional intensity (Philippot, Baeyens, & Douilliez, 2006). Furthermore, studies have found that individuals with a high working memory capacity are more effective at spontaneously regulating their emotions (Schmeichel & Demaree, 2010), and are better at regulating their emotions via reappraisal when instructed than those with lower working memory capacities (Schmeichel, Volokhov, & Demaree, 2008). The relationship between cognitive processes and emotion regulation has also begun to be examined in the context of depression, which is associated with a number of cognitive deficits (e.g. Joormann & D'Avanzato, 2010). One study has shown that depressed patients exhibit deficits in cognitive flexibility and fluency, and that these cognitive processes improve following treatment with antidepressant medication, suggesting a link between these cognitive deficits and emotion dysregulation in depression (Beblo, Baumann, Bogerts, Wallesch, & Herrmann, 1999). A more recent study has examined this relationship directly and found that cognitive control deficits characteristic of depression, particularly the reduced inhibition of negative material, contribute to less use of effective emotion regulation strategies such as reappraisal (Joormann & Gotlib, 2010).

Studies with neuropsychological patients lend further support for the link between cognitive processes, particularly cognitive flexibility, and emotion regulation. For example, among patients with Parkinson’s disease, performance on the Tower of London task, a measure of executive functions and specifically planning, has been associated with self-reported deficits in emotional stability (Volpato, Signorini, Meneghello, & Semenza, 2009). Studies involving patients with Traumatic Brain Injury have found similar relationships between executive functions and emotion regulation. In one study, patients with TBI were found to exhibit deficits in executive function as assessed via the Behavioural Assessment of the Dysexecutive Syndrome (BADS), and that performance on a subtest assessing multitasking predicted informant report of externalizing problems (Rochat, Ammann, Mayer, Annoni, & Van der Linden, M., 2009). Similarly, another study showed that patients with TBI were elevated in a measure of rule-breaking, suggesting deficits in impulsivity, and that the degree of this deficit was associated with informant report of loss of emotional control (Tate, 1999). Yet another study demonstrated that among TBI patients, deficits in performance on tasks assessing executive function, particularly working memory, predicted decreased use of planful problem solving and increased use of escape avoidance coping (Krpan, Levine, Stuss, & Dawson, 2007). Among patients with multiple sclerosis, a relationship has also been found between measures of executive function and measures of both depression and anxiety (Julian, & Arnett, 2009), again suggesting a link between deficits in cognitive control and deficits in emotion regulation.

Affective Processing and Affective Flexibility

Typical measures of cognitive processes include tasks involving non-affective stimuli, such as numbers or shapes. However, it has been recently proposed that separate mechanisms are involved in the processing of affective stimuli. For instance, a study that investigated the maintenance of affective material in working memory found that an emotion-regulation task, but not a cognitive task, disrupted memory for affective stimuli (Mikels, Reuter-Lorenz, Beyer, & Fredrickson, 2008). These results suggest that domain-specific components of working memory exist which are involved in the processing of affective material (Mikels et al., 2008), and introduce the possibility that other cognitive processes have domain-specific components for the processing of affective stimuli. Another cognitive process that has received more attention in this regard is cognitive flexibility, and it has been proposed that an affect-specific component of this cognitive process also exists. This domain-specific process has been termed ”flexible affective processing” (Genet & Siemer, 2011) or “attentional control capacity for emotion” (Johnson, 2009a), which refers to the ability to flexibly process affective material, such as words or images, by easily switching back and forth between processing the affective and non-affective components of the stimuli (Genet & Siemer, 2011). For example, this may involve switching mental sets in order to ignore processing of affective material and focus on a non-affective aspect of an emotionally evocative picture, such as evaluating the number of human beings present in the picture. This neutral information could then be used to re-evaluate the affective components of the picture from a different perspective.

To determine if cognitive flexibility and affective flexibility really are separable capabilities, cognitive flexibility paradigms have been adapted for use with affective material. Rather than asking participants to sort affect-neutral stimuli such as numbers, participants may be asked to categorize affective words (Genet & Siemer, 2011) or pictures (Johnson, 2009a) based on different rules. To properly assess switching to and from affective mental sets, one rule should require tapping into the affective content of the stimulus and another should draw on a non-affective component of the stimulus. For example, Genet and Siemer (2011) assessed affective flexibility by instructing participants to sort affective words based on two rules: whether the word was positive or negative, or whether the word was an adjective or a noun. On the other hand, Johnson (2009a) assessed attentional control capacity for emotion using affective images consisting of an emotional face with an affectively neutral shape between the face’s eyes. Participants were instructed to sort the images either based on the emotion of the face or the shape present (Johnson, 2009a). When compared with performance on general cognitive flexibility tasks, results of studies from both of these labs indicate that affective flexibility does exist and is separable from general cognitive flexibility (Genet & Siemer, 2011; Johnson, 2009b).

Affective Flexibility and Emotion Regulation

Given that reappraisal involves flexibility in switching between affective and non-affective mental sets, and that it is predicted by cognitive flexibility, it follows that affective flexibility might be a mechanism that is crucial for effective emotion regulation. Indeed, initial evidence does suggest that affective flexibility uniquely predicts emotion regulation and related outcomes (Genet & Siemer, 2011; Johnson, 2009a; Johnson, 2009b). Genet and Siemer (2011) examined the relationship between affective flexibility, reappraisal, and resilience, which is the ability of people to "bounce back" from stressful events (e.g. Block & Kremen, 1996). Although the authors did not directly investigate the link between affective flexibility and reappraisal, studies have found that individuals high in trait resilience are more likely to appraise situations positively than those low in trait resilience, and that reappraisal is associated with greater experience of positive emotions (Tugade & Fredrickson, 2004), indicating that these are related constructs. Importantly, the authors found that switching costs on the affective flexibility task predicted unique variance in trait resilience, controlling for switch costs on a general cognitive flexibility task and performance on a working memory task (Genet & Siemer, 2011). These results lend support to the notion that affective flexibility is a capability distinct from cognitive flexibility, and suggest that affective flexibility plays a key role in emotional well-being, over and above the role played by general cognitive flexibility. One potential shortcoming of this study was that affective flexibility was assessed using a sorting task involving affective words, which may or may not be emotionally evocative. Given that reappraisal involves situations which are emotionally evocative, using more emotionally evocative stimuli may improve the utility of this measurement tool.

Notably, two studies by Johnson have investigated the link between affective flexibility (attentional control capacity for emotion) and emotion regulation directly, using the image sorting task described previously (Johnson, 2009a; Johnson, 2009b). Two particular types of switch trials were examined in Johnson's studies, which included switches toward the non-affective rule (toward shape, away from emotion) and switches toward the affective rule (toward emotion, away from shape). Appropriate switch costs were calculated by subtracting reaction times from the corresponding repetition trials (Johnson, 2009a; Johnson, 2009b). For example, to calculate switch costs toward the shape rule, the reaction times for trials which were a repetition of the shape rule ($n_1-1 = n_1$) were subtracted from the reaction times for trials in which the rule switched to the shape rule ($n_2-1 \neq n_2$; $n_1 = n_2$). Examination of these switch costs indicated that participants who were able to quickly switch toward the shape rule (away from the emotion rule) experienced less frustration and persisted longer on a stressful anagram task; whereas those who were able to quickly switch toward the emotion rule (away from the shape rule) experienced more frustration and did not persist as long on the anagram task (Johnson, 2009a; Johnson, 2009b). These results propose that affective flexibility is important for spontaneous emotion regulation; and more specifically, that individuals who are able to more quickly inhibit an emotional task-set and switch toward a non-emotional task set are better at regulating their emotions than those who show a bias for an emotional task-set.

Current Study

Although the studies described above carry important implications for understanding the cognitive processes that contribute to effective emotion regulation, the current literature is limited in several regards. First, although measures of affective flexibility have been developed and validated in some research, these measures need further improvement and validation. For example, in Johnson's (2009a, 2009b) task, participants categorized pictures based on either the emotion of the face, or the shape between the face's eyes. Although this is a creative method of generating two different switching rules, the participants are, in effect, viewing two different pictures. Therefore, participants do not need to view the picture in its entirety in order to determine how to categorize it, and only need to attend to the relevant component of the picture. This seems to tap more into other cognitive emotion regulation strategies, such as distraction or attentional deployment, rather than the switching of mental set necessary for reappraisal. On the other hand, Genet and Siemer's (2011) task addressed this issue by asking participants to look at a word and categorize it either by its valence or its part of speech. Therefore, participants were required to attend to the word presented, regardless of the active sorting rule, and switch mental sets in order to categorize the word based on which sorting rule is active. However, because this task utilized words, rather than pictures, it is unclear if this sorting task measures the same construct. It has been shown that images are emotionally evocative (e.g. Lang, Bradley, & Cuthbert, 1997) and may have privileged access to systems devoted to affective processing (e.g. De Houwer & Hermans, 1994), suggesting that flexible processing of affective images may be separate from flexible processing of other affective stimuli.

Second, previous studies examining affective flexibility have looked at fairly general switch costs only. For example, Genet and Siemer (2011) examined only overall switch costs, regardless of trial type or stimulus type. Johnson (2009a) took a somewhat more specific approach to his analysis by examining switches toward specific categorization rules (e.g. switch cost associated with switching toward an emotion categorization trial), which did yield differential results. However, his analyses still failed to take into account the properties of the stimulus presented and how this may affect set switching. To obtain a greater degree of specificity, the present study intends to examine specific switch costs in terms of both the categorization rule being activated, as well as the affective nature of the stimulus being categorized. This approach will allow for the examination of how switch costs may differ based on the valence of the picture presented. For example, it may be more difficult for individuals to switch away from categorizing the valence of an image when the image is negative, compared with when the image is positive.

Third, although previous studies have provided some indirect evidence for the relationship between affective flexibility and emotion regulation indirectly, no study to date has examined this relationship directly. Johnson (2009a) intended to tap into emotion regulation by assessing participant's emotion ratings following a stressful anagram task. However, no baseline ratings of emotion or measures of emotional reactivity were obtained, precluding firm conclusions regarding decreases in emotional experience. Additionally, these participants were not asked to regulate their emotions prior to the task, nor were they asked following the task how they regulated their emotions, so it is unclear if emotion regulation indeed occurred. In order to address this limitation, participants in this study will partake in a directed emotion regulation task, during which they will watch a film clip designed to elicit sadness and will be asked to regulate their emotional responding in a particular way. This type of emotion regulation task will allow this study to relate affective flexibility to emotion regulation, reappraisal in particular, due to its specificity.

Finally, no studies currently exist examining the relationship between online emotion regulation and affective flexibility, and how this may differ from the relationship between antecedent-focused emotion regulation and affective flexibility. Previous studies have found that online emotion regulation, specifically reappraisal, requires more cognitive control resources than antecedent-focused reappraisal (Sheppes & Meiran, 2008; Sheppes et al., 2009). However, it is currently unclear which particular cognitive control resources are associated with online reappraisal.

In order to address the above limitations, the present study will be designed to systematically examine affective flexibility using a novel task, and to determine its relationship with both antecedent-focused and online reappraisal using a directed emotion regulation task. The affective flexibility task will be developed based on the affective word task utilized by Genet and Siemer (2011). This task will present the participant with emotionally evocative images taken from the International Affective Picture System, a widely used, standardized collection of affective images (IAPS; Lang, Bradley, & Cuthbert, 2008), and ask that participants categorize these images based on different sorting rules. This task, the Flexible Affective Processing of Pictures (FAP-P) task, will serve as a more precise measure of affective flexibility due to its use of a standardized emotionally evocative picture set and unique method of examining set switching. Further, performance on this task will be analyzed in general terms, as well as in terms of particular rule-switches and image valence, such that specific switch costs can be studied. To examine affective flexibility's relationship with reappraisal, participants will complete a directed emotion regulation task. To determine if the relationship between affective flexibility and emotion regulation differs as a function of when emotion regulation is initiated, participants will receive instructions to begin reappraisal either at the film's outset (antecedent-focused) or approximately half way through the film (online). Further, to control for emotional reactivity, participants will complete questionnaires intended to assess for associated personality traits including neuroticism and behavioral inhibition.

Hypotheses

Based on the state of the current literature, the following hypotheses were generated. (1) The new FAP-P task measures a construct distinct from general cognitive flexibility. It is expected to correlate with a measure of general cognitive flexibility, but not perfectly. (2) Switching costs on the affective flexibility task will predict sadness intensity at the end of the reappraisal task, controlling for general cognitive flexibility, emotional reactivity as indexed via neuroticism, and depressive symptomatology. (3) The relationship between switching costs on the affective flexibility task and sadness at the end of the reappraisal task will be stronger in the online condition than in the antecedent-focused condition. (4) An exploratory analysis of associations between specific switch costs and sadness at the end of the reappraisal task will reveal differences in the way certain switch costs relate to emotion regulation outcomes.

Chapter 2: Methods

Participants

The sample used in this study included 165 undergraduate students recruited from introductory psychology courses at the University of Miami. Participants were recruited through an online database used to manage psychology experiments, wherein participants signed up to participate in experiments in return for course credit. The sample was composed of participants ranging in age from 17 – 25 (M = 19.34, SD = 1.16), with 53% females. The sample was also ethnically diverse, with 53% Caucasian, 8.5% African American, 19.5% Hispanic, 11.6% Asian, 1.2% Middle Eastern, and 6.1% other.

Measures

Participants were asked to complete a demographics questionnaire and a series of personality measures presented on personal computers using Filemaker Pro 5. Additionally, participants completed several cognitive tasks on personal computers running E-Prime 2 assessing general cognitive flexibility and affective flexibility. In addition, participants described their emotional experience following the emotion regulation task and completed a retrospective questionnaire assessing their reactions during the emotion regulation task. The specific measures used are outlined below.

Demographics. Participants completed a questionnaire inquiring about basic demographic information, including age, gender, and ethnicity. Additionally, baseline mood was assessed by asking participants to rate how sad, happy, and angry they felt on a scale from 1 to 5, with 1 being "not at all" and 5 being "extremely." Participants were also asked to report how tired and confused/disoriented they were.

Neuroticism. The Big Five Inventory (BFI; John, Donahue, & Kentle, 1991) was used to assess the personality trait neuroticism (e.g. "Worries a lot"), a personality trait which is related to emotional reactivity. Respondents were asked to indicate their agreement with statements on a 5-point scale ranging from 1 = "disagree" to 5 = "agree strongly." The BFI has been found to be psychometrically sound in various American samples (John & Srivastava, 1999).

Depression. The Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) was used to assess participants' level of depressive symptomatology. Participants were asked to indicate their agreement with various statements representative of depressive symptoms (e.g. "I felt depressed") on a 4-point scale ranging from 0 = "Rarely or none of the time (less than 1 day)" to 3 = "Most or all of the time (5-7 days)." The CES-D has been found to be psychometrically sound and a good predictor of individual differences in depressive symptomatology in college undergraduates (Santor, Zuroff, Ramsay, Cervantes, & Palacios, 1995).

Emotional Experience. Participants' mood was assessed immediately following the emotion regulation task by presenting them with 3 mood items on a computer screen representative of sad mood ("down," "sad," "depressed"). Participants were asked to rate these items based on a 7-point scale by pressing a computer key, with 1 = "not at all" and 7 = "a great deal."

Emotion Regulation Follow-Up Questionnaire. Participants also completed a follow-up questionnaire assessing their understanding of the instructions during the emotion regulation task and their emotional reactions during the task (see Appendix).

General Cognitive Flexibility. Participants completed a modified version of Schneider and Logan's (2005) task-switching paradigm in order to assess general cognitive flexibility. Participants were presented with both a cue ("odd – even" or "higher than 5 – lower than 5") and a number (ranging from 1-9) simultaneously and categorized the number based on the cue by pressing one of two adjacent keys on a computer keyboard. This task required participants to inhibit the previous rule and switch from the previous rule to a new one in order to make a correct categorization.

Flexible Affective Processing. Flexible affective processing was assessed using a novel task, the Affective Picture Switching task. This task was similar in design to Genet and Siemer's (2011) Affective Word Switching task and assessed affective flexibility by asking participants to categorize affective images according to different rules. Participants were presented with an affective picture surrounded by a colored frame, with the trial cue presented in the left and right sides of the frame ("+" and "-" for positive and negative, or "≤1" and "≥2" for one or fewer human beings and two or more human beings). Participants were instructed to categorize the affective pictures according to the cue using two adjacent keys on a computer keyboard. The combination of the active categorization rule (e.g. positive – negative) and picture type (e.g. negative image with 2 or more human beings depicted) changed according to a pseudorandom sequence. The Affective Picture Switching Task requires participants to switch between affective and non-affective task sets by inhibiting the previous categorization rule and switching from the previous rule to the new rule. Furthermore, because pictures are emotionally evocative (Coan & Allen, 2007; P. J. Lang et al., 2008), this task requires participants to attend to or inhibit emotionally salient information in order to correctly categorize the pictures, which seems particularly relevant for successful cognitive reappraisal.

The pictures used in this task were selected from the International Affective Picture Set (IAPS; P. J. Lang et al., 2008). All positive pictures had a mean valence rating between 8 and 6, and all negative pictures had a mean valence rating between 2 and 4. These ranges of affective space were chosen in order for the pictures to evoke emotion with as little interference on the task performance as possible. Pictures were also selected based on ease of categorization according to pilot data. Seven research assistants from our laboratory categorized IAPS pictures based on the two different rules: they first categorized all of the pictures according to the valence of the picture (positive – negative), then according to the number of human beings in the picture (one or fewer human beings – two or more human beings; cf. Hajcak, Moser, & Simons, 2006). These data were analyzed, and pictures were selected to be in the final picture set if at least six out of seven research assistants agreed on the categorization of the picture according to both rules. The final set of pictures included 160 IAPS pictures split into four groups of 40 based on the valence of the picture and the number of human beings in the picture (e.g. positive with one or fewer human beings depicted). Positive (M = 7.38, SD = .376) and negative (M = 2.723, SD = .531) pictures differ from one another in terms of their mean valence, $t(158) = 64.062$, $p < .001$. The positive and negative image sets also differ in terms of mean arousal (Positive: M = 4.849, SD = .823; Negative M = 5.596, SD = .876), $t(158) = 5.555$, $p < .001$. The IAPS technical manual states that low-arousing negative pictures are generally under-represented, leading to the researchers' difficulty in including pictures within this affective space (IAPS; Lang et al., 2008). Additionally, a study has found a negative correlation between valence and arousal within the IAPS pictures, such that as pictures become more positive, arousal ratings tend to decrease (Ito, Cacioppo, & Lang, 1998). When comparing pictures based on the number of human beings, pictures with one or fewer human beings (M = 5.086, SD = 2.350) did not differ from pictures containing two or more human beings (M = 5.021, SD = 2.429) in terms of valence, $t(158) = .171$, $p = .864$. The two groups of pictures did differ somewhat in terms of arousal (one or fewer M = 5.043, SD = .949; two or more M = 5.402, SD = .873), $t(158) = 2.488$, $p = .014$. However, the mean difference in arousal was quite small and the effect size, $\eta^2 = .038$, indicated that although the effect is statistically significant, it is likely not practically significant.

Emotional stimuli

A 3:47-minute film clip from the commercially available movie *The Champ* was shown during the emotion regulation task (Zeffirelli, 1979). The film clip depicted a young boy who witnessed his father's death following a fatal boxing match. This film clip has been shown to reliably elicit sadness in previous studies (e.g. Gross & Levenson, 1995).

Participants were also shown a 3:00-minute film clip from an episode of the television series *Mr. Bean* (Birkin, 1995). The film clip depicted a comedic scene in which the main character arrived in a hospital waiting room with a tea kettle stuck over his hand.

Procedure

The experimental protocol was administered to participants in groups of up to 8, and each participant completed the computer tasks on his or her own computer within a cubicle-like enclosure. Participants began by completing the demographics and self-report questionnaires, and then completed the Affective Picture Switching task, the cognitive flexibility task, and finally the emotion regulation task. Each participant completed the tasks in the same order; however, versions of each task were counterbalanced across participants. The self-report questionnaires were administered using Filemaker Pro 5 on a 19" computer monitor. The affective flexibility, cognitive flexibility, and emotion regulation tasks were also presented on a 19" computer monitor and run using E-Prime software. Participants were seated approximately 1.5 feet away from the computer monitor.

Cognitive flexibility and flexible affective processing tasks. The cognitive flexibility task began with two 24-trial practice blocks, during which participants sorted numbers based on one rule per block. The third block contained 240 trials and required participants to sort numbers based on both rules, which alternated according to a pseudorandom sequence. During this block, the trial cue switched after two to five trials. Similarly, the Affective Picture Switching task began with two 10-trial practice blocks during which participants sorted affective pictures based on one rule per block. The third and fourth blocks consisted of 160 trials each and required participants to sort affective pictures according to both rules, which again changed according to a pseudorandom sequence. This task was broken into two blocks of 160 trials, rather than one block of 320 trials, in order to prevent participant fatigue. Trials during the cognitive flexibility and affective flexibility tasks could involve a repetition of the rule from the previous trial (repetition) or a change in the rule compared with the previous trial (switch). Switching costs, the additional time required to categorize a picture after a rule switch, were calculated for both tasks by subtracting reaction times for repetition trials from reaction times for switch trials.

In both flexibility tasks, participants were instructed to use their right-hand index finger to press the left-side key and their right-hand middle finger to press the right-side key. Participants were instructed to respond as quickly and accurately as possible. In both tasks, the cue and stimulus remained on the screen until a response was made, with no time limit for the response. Upon logging a response, participants were presented with a fixation screen, followed by a new cue and stimulus. The cues and numbers for the cognitive flexibility task were presented with a 26-point, Courier New font, with white text on a black background. The instructions for the Affective Picture Switching task were presented with a 20-point, Arial font, with white text on a black background. The cues for the Affective Picture Switching task were presented with a 65-point, Courier New font, with either black text on a white background or black text on a grey background. The Affective Picture Switching task was counterbalanced across participants in terms of which frame color corresponded to which cue (e.g. a white frame corresponded with valence and a grey frame corresponded with the human rule for half of participants, and vice versa) as well as the mapping of the cues onto the keys (e.g. "+" was on the left and "-"was on the right for half of participants, and vice versa), resulting in 8 versions.

Emotion regulation task. Participants were randomly assigned to one of four conditions for the emotion regulation task, based on when they received the instruction to begin reappraising and the instructions they received. Participants were instructed to either initiate reappraisal at film onset (early group) or approximately halfway through the film clip (late group). Furthermore, half of participants received counter-demand instructions in order to control for biased responding, which informed participants that previous studies have found that reappraisal is very difficult and may even backfire, causing increased emotions. Initially, all participants were presented with the following instructions to orient themselves to the emotion regulation task, presented on 3 different screens:

> IMPORTANT! PLEASE READ CAREFULLY!
>
> You are about to watch a short scene taken from a film. Please view the film carefully.
>
> In addition, you may be asked to view the film in different ways. This will be indicated by a subtitle on the bottom of your screen.
>
> If you see the subtitle "view normally" we ask that if any emotions arise while viewing the film clip, please try your best to experience them and not to block yourself from feeling. For example, if the film arouses anger in you, simply try to experience that emotion without holding back your feelings.
>
> If you see the subtitle "decrease emotion" we ask that you try your best to adopt a neutral attitude toward the film. To do so, we would like for you to view the film as if you were a scientist who examines the film objectively. Try to think about the film objectively and analytically rather than personally, or any way emotionally relevant to you. So watch the film carefully, but please try to think about what you are seeing in a way that you don't feel anything at all.
> Please try your best to follow these instructions at all times.

Two instruction checks were in place, one following the “view normally” instructions and another following the “decrease emotion” instructions, to allow participants to return to the instruction screen in case they were unsure of what to do or did not read the instructions carefully. Next, half of the participants (the counter-demand groups) were presented with an additional instruction screen in order to control for demand effects, which informed them of the difficulty of reappraisal. The instruction presented differed based on whether participants were in the early or late counter-demand group. The late counter-demand group received the following instructions:

> Please note that in previous studies, we have found that it was very difficult for participants to decrease emotions later on in the film. In particular, some participants expressed that their connection with the story and its characters made it impossible to decrease their emotions.

The early counter-demand group received the following instructions:

> Note that we found that actively trying to decrease one's emotions while watching a film can be challenging. For some participants, trying to decrease their emotions actually backfired, that is, it increased their emotions compared to when they viewed the film normally.

At this point participants began watching the film-clip from *The Champ* (Zeffirelli, 1979). The film clip was presented in a widescreen format with mattes on top of and underneath of it. Participants in the early reappraisal groups were instructed to begin reappraisal at film onset by a "decrease emotion" cue presented in the matte underneath of the film clip throughout the duration of the film clip. Participants in the late reappraisal groups were presented with the "view normally" cue in the matte underneath of the film clip for the first 1:47 minutes of the film clip, then were presented with the cue to "decrease emotion" in the matte beneath the film for the rest of the film clip. The cues were displayed in an 18-point Arial font, with the "view normally" cue presented as white text on a black background, and the "decrease emotion" cue presented as black text on a white background. The change in background and word color was intended to help participants to notice the change in the cue. At the end of the film clip, participants were asked to rate items representative of sad mood, and then completed the emotion regulation follow-up questionnaire.

Upon completion of the emotion regulation follow-up questionnaire, participants watched the film clip from Mr. Bean so that all participants would have the opportunity to repair their mood before leaving the lab.

Chapter 3: Results

Preliminary Analyses

Data Preparation and Screening. Participants' data from the two task switching tasks were first examined for overall accuracy. Three participants who performed worse than chance on the cognitive flexibility task and two participants who performed worse than chance on the affective flexibility task (accuracy < 50%) were eliminated from further analyses. All RTs from inaccurate trials were also eliminated from further analyses so that switching costs were only calculated based on accurate trials. This resulted in 8.24% of trials being eliminated from the cognitive flexibility task analyses, and 11.71% of the trials from the affective flexibility task being eliminated from analyses. The influence of RT outliers was reduced by using a reaction time window of 2.5 standard deviations around the mean. RT values which were more than 2.5 standard deviations below or above the mean were replaced with the value corresponding to 2.5 standard deviations below or above the mean. This approach has been used in similar studies involving reaction time data (e.g. Greenwald, Nosek, & Banaji, 2003).

Furthermore, data from the Emotion Regulation Follow-Up Questionnaire were examined to determine if participants adhered to the instructions. Participants' responses to questions inquiring about the emotion regulation strategy used during the emotion regulation task were coded by two trained research assistants with good inter-rater agreement ($\kappa = .75$). Disagreements between the two raters were resolved through the additional examination of the participant's response by this writer. Thirty participants who reported using emotion regulation strategies that were clearly unrelated to reappraisal (e.g. "I turned and looked away," "I tried to breathe deeply to slow my heart rate," etc.) were eliminated from further analyses. Participants' responses regarding which cue(s) they remembered seeing during the reappraisal task were also compared with the cue(s) that they actually received, and participants' data was eliminated from analyses if differences were noted. Participants' data was also eliminated if they received the counter-demand instructions, but did not indicate that they remembered these instructions. This resulted in the removal of an additional 13 participants from further analyses. In total, the above screening resulted in a final sample size of 117.

In addition to creating a sadness scale by combining the three sadness items (Cronbach's alpha = .95), a sadness difference score was also calculated to control for differences in participants' sad affect at baseline. Participants' baseline response to the item assessing sad affect and the sadness scale were both *z*-transformed, and participants' baseline mood *z*-score was subtracted from their post-reappraisal sadness *z*-score.

To investigate the possibility of demand effects on self-report, sadness ratings at the end of the task were compared between the regular instruction and counter-demand instruction conditions. An independent samples *t*-test found that the two groups did not differ significantly on sadness ratings, $t(115) = .82$, $p = .41$, nor did they differ on perceived difficulty of emotion regulation, $t(115) = .63$, p = .53. Thus, the two groups were combined and treated as equivalent for the remainder of the analyses.

Calculation of Switch Costs.

Cognitive Flexibility Task. The presence of switch costs was established with a paired samples *t*-test comparing reaction times on switching trials with reaction times (RTs) on repetition trials. Results indicated that RTs on switching trials (M = 1211, SD = 169) were significantly higher than RTs on repetition trials (M = 993, SD = 138), $t(116)$ =

23.11, p<.001,confirming the presence of switch costs. After switch costs were established, individual participant's average general switch costs were calculated by subtracting their average repetition trial RT from their average switching trial RT.

Affective Flexibility Task. The above procedure was repeated in order to calculate general switch costs for the affective flexibility task. Results of a paired samples t-test showed that RTs on switch trials (M = 1499.87, SD = 309.66) were significantly higher than RTs on repetition trials (M = 1343.08, SD = 264.66), $t(116) = 18.08$, $p < .001$, indicating the presence of switch costs. Next, specific switching costs for different trial types were calculated. For example, the specific switch cost associated with switching toward the non-affective (human being) rule in the presence of a negative image was calculated. This switch cost was calculated by subtracting RTs on trials in which the affective (valence) rule is repeated in the presence of a negative picture, from RTs on trials in which the cue switches to the non-affective (human being) rule in the presence of a negative picture. In the same way, specific switching costs were calculated for switches toward the non-affective rule in the presence of a positive image by subtracting RTs on trials in which the affective rule is repeated in the presence of a positive picture, from RTs on trials in which the cue switches to the non-affective rule in the presence of a positive picture. Specific switch costs were also calculated for switches toward the affective rule in the presence of a negative picture by subtracting RTs on trials in which the non-affective rule is repeated in the presence of a negative image, from RTs on trials in which the cue switches to the affective rule in the presence of a negative image. Finally, switch costs toward the affective rule in the presence of a positive picture were calculated by subtracting RTs on trials in which the non-affective rule is repeated in the presence of a positive image, from RTs on trials in which the cue switches to the affective rule in the presence of a positive image.

Speed-Accuracy Trade-Off. To ensure that general switch costs on the cognitive flexibility task and affective flexibility task were not due to a speed-accuracy trade-off (e.g. as RT speed increases, accuracy goes down), a paired samples *t*-test was conducted to compare accuracy during switch trials with accuracy during repetition trials. Analyses of cognitive flexibility task data revealed that accuracy during switch trials (M = .94, SD = .07) did not differ from accuracy during repetition trials (M = .94, SD = .06), $t(116) = .50$, $p = .62$, suggesting that a speed-accuracy trade-off is not present. Furthermore, results from the affective flexibility task indicated that accuracy during switch trials (M= .90, SD= .07) was significantly lower than accuracy during repetition trials ($M = .91$, $SD = .06$),$t(116) = 5.06$, $p< .001$, again providing evidence that a speed-accuracy trade-off is not present.

Analyses

Hypothesis 1: The FAP-P task measures affective flexibility, a construct distinct from general cognitive flexibility. To test the hypothesis that the FAP-P task assessed a construct similar to, but distinct from cognitive flexibility, a bivariate correlation was calculated examining the association between general switch costs on the cognitive flexibility task and the FAP-P task. I expected to find a moderate positive correlation between general switch costs on the affective flexibility and cognitive flexibility tasks, indicating that the tasks are related but are tapping into separate constructs. Surprisingly, no association was found between the cognitive flexibility task and the affective flexibility task, $r = .12$, $p > .20$, suggesting that these two tasks may tap into unique constructs.

Hypothesis 2: Switching costs on the affective flexibility task will predict sadness intensity. To determine if overall switching costs on the affective flexibility task predicted sadness ratings at the end of the reappraisal task, a regression analysis was run with overall switch costs on the affective flexibility task as the independent variable, and intensity level on the sad mood scale constructed from the emotional experience items as the dependent variable. I predicted that overall switch costs on the affective flexibility task would explain variance in the sad mood scale. The results of this regression revealed that overall switch costs on the affective flexibility task were not a significant predictor of sad mood, $F(1, 115) = 2.01$, $p > .10$. Furthermore, another regression was run with the sad mood difference score regressed onto overall affective flexibility switch costs, in order to control for baseline sadness. Again, this regression equation was not significant, $F(1,114) = 2.44$, $p > .10$.

Next, to control for the potential influence of general cognitive flexibility on reappraisal, as this may have been operating as a classical suppressor, I ran a hierarchical multiple regression analysis including overall switch costs on the cognitive flexibility task and overall switch costs on the affective flexibility task as independent variables, and the sad mood scale as the dependent variable. To control for general cognitive flexibility, overall switch costs on the cognitive flexibility task were entered in step one of the regression equation, and switch costs on the affective flexibility task were entered in step two of the regression equation. I predicted that overall switch costs on the affective flexibility task would predict unique variance in sad mood, over and above that predicted by overall switch costs on the cognitive flexibility task. Surprisingly, results of this regression were also not significant, $F(2, 114) = 1.13$, $p > .30$. To control for baseline sad mood, this process was repeated by regressing the sad mood difference score onto overall cognitive flexibility switch costs and overall affective flexibility switch costs. Again, this regression was not significant, $F(2, 113) = 1.58$, $p > .20$.

Finally, to control for emotional reactivity and depression, which both affect emotion regulation, additional hierarchical multiple regression analyses were run which controlled for neuroticism and scores on the CES-D. Similar to the previous analyses, neuroticism, CES-D total score, and overall switch costs on the cognitive flexibility task were entered into step one of the regression equation, and overall switch costs on the affective flexibility task were entered into step two. I predicted that overall switch costs on the affective flexibility task would predict unique variance in sad mood, over and above that predicted by overall switch costs on the general cognitive flexibility task, emotional reactivity, and depressive symptomatology. Although this regression equation was significant, $F(3, 109) = 3.16$, $p < .05$, the CES-D total score, $\beta = .24$, $p < .05$ was the only significant predictor in the regression equation. To control for baseline sad mood, the sad mood difference score was also regressed onto overall cognitive flexibility task switch costs, neuroticism, CES-D total score, and overall affective flexibility task switch costs. This regression equation was not significant, $F(4, 109) = 2.00$, $p = .10$

Hypothesis 3: The timing of reappraisal initiation (early vs. online) will moderate the relationship between affective flexibility and sadness intensity, such that this relationship will be stronger in the online reappraisal group compared with the early reappraisal group. To test for moderation, a moderated regression analysis was run examining if the relationship between overall switch costs on the affective flexibility task and sadness differs between the online and early reappraisal groups. To create the independent variables for the regression, reappraisal group membership was dummy-coded, overall affective flexibility task switch-costs were centered, and the interaction term was created by multiplying the reappraisal group membership variable by the centered overall affective flexibility task switch cost variable. The dependent variable, the sad mood scale, was also centered. The centered sadness scale was then regressed onto the three independent variables with the dummy coded reappraisal group variable and centered overall affective flexibility task switch costs entered in the first block of independent variables, and the interaction term entered in the second block of independent variables. I predicted that the timing of reappraisal initiation would significantly moderate the regression analysis, and that switch costs on the affective flexibility task would be a stronger predictor of sadness in the online reappraisal group compared with the early reappraisal group. The results of this moderated regression, however, were not significant, $F(3, 113) = 0.691$, $p > .50$. This process was repeated to control for baseline sad mood by regressing the dichotomous reappraisal group variable, centered overall affective flexibility task switch costs, and the interaction term on the sad mood difference score. Again, this regression equation was not significant, $F(3, 112) = 1.20$, $p > .30$.

Exploratory Analyses: Specific switch costs on the affective flexibility task will be associated with sadness following the reappraisal task. I also conducted exploratory analyses to investigate the relationships between specific affective flexibility task switch costs (e.g. toward the non-affective rule, while viewing a negative image) and sadness intensity following the emotion regulation task. This was accomplished by first analyzing bivariate correlations among these variables, and then following up significant correlations by running separate linear regressions with one specific affective flexibility task switch cost as the independent variable, and the two sadness scales as the dependent variables. Examination of the intercorrelations among the sad mood measures and the affective flexibility task specific switch costs (see Table 1) revealed that switch costs associated with switches toward the human (non-affective) categorization rule in which the target image was negative were significantly associated with sad mood following the reappraisal task, $r = .19$, $p < .05$, as well as the sad mood difference score, $r = .18$, $p = .05$.

These significant correlations were then followed up with linear regression analyses. First, the sad mood scale was regressed onto affective flexibility task switch costs associated with switches toward the human (non-affective) categorization rule in which the target image was negative. This regression equation was significant, $F(1, 112) = 6.21$, $p < .05$, indicating that these specific switch costs on the affective flexibility task predicted sad mood, $\beta = .19$, $t = 2.08$, $p < .05$. The sad mood difference score was also regressed onto these affective flexibility task switch costs, and this regression equation was also significant, $F(1, 111) = 3.90$, $p = .05$, indicating that these specific switch costs remain a significant predictor of sad mood following reappraisal when controlling for baseline mood, $\beta = .18$, $t = 1.97$, $p = .05$.

Next, to determine if these specific affective flexibility switch costs predict sadness following reappraisal over and above general cognitive flexibility, a hierarchical regression was run in which overall cognitive flexibility task switch costs were entered into block one, specific affective flexibility task switch costs were entered into block two, and the sad mood scale was regressed onto these variables. Although the full regression equation was not significant, adding affective flexibility specific switch costs improved the significance of the regression equation, and these switch costs were a significant predictor of sad mood (see Table 2). When the sad mood difference score was regressed onto overall cognitive flexibility task switch costs and affective flexibility task specific switch costs, the same pattern emerged: although the equation was not significant, these affective flexibility switch costs improved the significance of the equation and were a significant predictor of sad mood (see Table 2).

Finally, to examine if the effect of affective flexibility task specific switch costs remains after controlling for neuroticism and depressive symptomatology, as well as general cognitive flexibility, additional hierarchical regressions were run with overall cognitive flexibility switching costs, neuroticism, and CES-D scores entered into step one of the equation, and affective flexibility task specific switch costs entered into step two of the equation. When the sad mood scale was regressed onto these independent variables, the resulting equation was significant, and affective flexibility task specific switch costs were trending toward being a significant predictor of sadness (see Table 3). Furthermore, the sad mood difference score was also regressed onto the same independent variables. Although the equation was only trending toward significance, affective flexibility task specific switch costs emerged as a significant predictor of sad mood, over and above that predicted by the other variables (see Table 3).

Chapter 4: Discussion

In the present study, the relationship between executive control and cognitive reappraisal was examined. I proposed that the change of interpretation characteristic of cognitive reappraisal involves flexibly shifting among task sets; thus, cognitive flexibility is essential for cognitive reappraisal. Furthermore, I argued that flexible processing of affective material, particularly emotionally evocative material, is distinct from flexible processing of neutral material, and that affective flexibility should be a better predictor of successful cognitive reappraisal than general cognitive flexibility. A primary aim of the current study was to determine if individual differences in affective flexibility predict individual differences in cognitive reappraisal. A secondary aim of the study was to determine if individual differences in affective flexibility are particularly important for online cognitive reappraisal, initiated as an emotion-triggering event is unfolding. In order to measure affective flexibility, the Flexible Affective Processing of Pictures task was used, which was a modified version of Genet and Siemer's (2011) Flexible Affective Processing of Words task. This task required participants to switch between an affective and a non-affective task set in order to categorize affective images. Furthermore, because the affective images were emotionally evocative, I hypothesized that this task-switching task may tap into cognitive processes specifically related to emotion regulation and cognitive reappraisal.

Regarding the primary aim, the results indicated that although individual differences in overall flexible affective processing did not predict individual differences in cognitive reappraisal effectiveness, specific switching costs did. Switching costs associated with switching away from an affective task set and toward a non-affective task set, when the image to be categorized was negative, predicted how sad participants felt following a directed reappraisal task. This switch required participants to inhibit processing of the picture's negative affect in order to process non-affective information, which is reminiscent of the change of interpretation characteristic of reappraisal. Furthermore, this finding is consistent with recent findings regarding the role of executive control and emotion dysregulation in affective disorders, which indicate that measures of executive control which use emotional material are often better predictors of psychopathology and vulnerability than classic executive control tasks, which use affectively neutral material (Joormann et al., 2010). Studies have also shown that individuals with depression exhibit a range of executive control deficiencies, such as cognitive inflexibility and poor inhibition of negative material, which in turn lead to emotion regulation deficits (e.g. Joormann & D'Avanzato, 2010). Therefore, it makes sense that these same relationships would be present in a non-clinical sample.

These results also make sense in the context of neuropsychological studies of the relationship between executive control and emotion regulation. Studies with various patient populations have found that deficits in executive functioning are associated with deficits in emotion regulation. An association between measures of executive function and constructs related to emotion regulation has been found in patients with Parkinson's disease (Volpato, Signorini, Meneghello, & Semanza, 2009), multiple sclerosis (Julian, & Arnett, 2009), and TBI (Krpan, Levine, Stuss, & Dawson, 2007; Tate, 1999), all of which have been shown to affect the frontal cortex. Thus, it makes sense that the present study found a relationship between these constructs, as they seem to share common neural substrates.

It is important to note the distinction between the Flexible Affective Processing of Pictures task used in this study and Johnson's measure of Attentional-Control Capacity for Emotion (Johnson, 2009). Whereas Johnson's task requires participants to deploy visual attention to different aspects of a complex image, the Flexible Affective Processing of Pictures task does not require visual attentional deployment. Rather, to be successful in this task, participants must process the same visual information using two different mental task sets. A recent study has found evidence that successful reappraisal does not necessarily involve the shifting of visual attention by showing that participants could successfully use reappraisal to regulate their emotional response to negative pictures, even when their gaze was directed to circumscribed areas of the picture (Urry, 2010). The present paradigm requires participants to shift attention to the neutral or emotional aspects or meaning of the pictures, but this does not necessarily require actual gaze shifts. For example, when asked to judge the number of human beings in a picture (neutral processing rule), participants have to attend to the people in the picture, an area that typically contains the most emotional information. Thus, this task requires that participants shift task sets, but not visual gaze per se, suggesting that this task taps into processes more closely related to the shift of task set characteristic of cognitive reappraisal rather than attentional deployment.

Furthermore, these results indicated that the Flexible Affective Processing of Pictures task is not simply a measure of general cognitive flexibility, as there was no association between this measure and the measure of cognitive flexibility. This indicates that the Flexible Affective Processing of Pictures task assesses a unique construct, affective flexibility. Additionally, this task contributes unique information toward the understanding of factors which contribute to effective cognitive reappraisal, as affective flexibility predicted unique variance in cognitive reappraisal effectiveness over and above that predicted by general cognitive flexibility, emotional reactivity, and depressive symptomatology. Flexible affective processing therefore seems critical to our understanding of individual differences which contribute to effective emotion regulation.

Regarding the secondary aim, flexible affective processing was not a better predictor of reappraisal effectiveness when reappraisal was initiated online, compared with antecedent-focused reappraisal. This was surprising, given that studies have shown that online reappraisal utilizes more cognitive control resources and is less effective than antecedent-focused reappraisal (Sheppes & Meiran, 2007; 2008), as well as being associated with increased sympathetic activation (Sheppes et al., 2009), suggesting that it is more effortful. These results, however, were unique in that a difference in sadness ratings was not found between subjects who initiated antecedent-focused reappraisal versus online reappraisal. This unexpected lack of variance in sadness ratings may explain why support for this hypothesis was not found. Alternatively, other factors in addition to affective flexibility, such as working memory capacity or attentional deployment, may contribute to effective online reappraisal.

The current study was unique in that it was the first study to examine flexible processing of affective, emotionally evocative stimuli. Furthermore, it was the first study to examine the relationship between an affective control process and directed cognitive reappraisal, ensuring that participants were both regulating their emotions and using this particular strategy. However, several limitations of the present study deserve mention. One important limitation was that data on sad affect was entirely self-report in nature, and participants are not always the best reporters of their own affective states. Although I attempted to control for demand effects by including counter-demand instructions, future studies should examine if affective flexibility predicts psychophysiological measures of affective states, such as heart rate variability, skin conductance, or late positive potentials. Furthermore, the sadness difference score used in our analyses was calculated via data collected from participants retrospectively. This method was used in order to not disrupt participants' emotional experience during the film clip; however, sadness ratings taken throughout the task could have improved the utility of sadness ratings.

The current study was also limited by some sample characteristics. One possible limitation was the group format of study sessions, as participants may have felt more self-conscious about their emotional expression in this environment. However, this environment may also increase participants' motivation to regulate their emotions so as not to show an emotional response to the sad film. Furthermore, a large number of subjects were eliminated from my analyses due to using a strategy other than cognitive reappraisal during the emotion regulation task. Although this was necessary in order to ensure that reappraisal effectiveness was being assessed, rather than general emotion regulation effectiveness, this could be prevented in future studies by going over the reappraisal instructions with participants verbally and encouraging participants to ask questions about the instructions. Participants may also complete sample reappraisal scenarios to ensure understanding of the instructions.

Despite the above limitations, the present study contributes unique knowledge to the literature on cognitive processes and emotion regulation. These findings have implications for how we conceptualize cognitive reappraisal as well as processing of emotional material. It appears that individuals may have a unique capacity for flexible processing of emotionally evocative material, separate from the capacity for flexible processing of non-affective material. The Flexible Affective Processing of Pictures task contributes unique information to our understanding of individual differences in cognitive reappraisal, over and above other measures of constructs relevant to emotion regulation. Furthermore, the utility of examining affective processing has been supported for non-clinical populations, and this construct is likely very relevant for the development and maintenance of mood and anxiety disorders, as well as in identifying deficits in emotional processing in neuropsychological patients. A task like the Flexible Affective Processing of Pictures task may eventually provide unique information to clinicians in determining emotion regulation deficits in clients seeking therapy or in assessing deficits in emotion regulation in patient populations.

In order to increase knowledge on affective processes and emotion regulation, future studies should re-examine the relationship between affective flexibility and cognitive reappraisal using objective psychophysiological methods. It will also be important to determine if affective flexibility is specific to cognitive reappraisal, or if it is also implicated in the effectiveness of other emotion regulation strategies such as attentional deployment, distraction, or expressive suppression. The generalizability of affective flexibility in predicting regulation of other emotions via cognitive reappraisal, such as fear, anger, or happiness, should also be examined. Furthermore, it is unclear if affective flexibility is a state or trait capacity, and if mood inductions or training may be used to increase affective flexibility. If affective flexibility may be trained, this may be a method of improving an individual's emotion regulation skills which should be studied further.

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Table 1. *Intercorrelations among Sad Mood Measures and Affective Flexibility Task Specific Switch Costs*

	Sad Mood Measures		Affective Flexibility Task Switch Costs		
	Sadness Scale	Difference Score	Affect Positive	Affect Negative	Human Positive
Sad Mood Measures					
Sadness Scale	1.0	--	--	--	--
Difference Score	.66***	--	--	--	--
Affective Flexibility Task Switch Costs					
Affect Positive	.09	.17	--	--	--
Affect Negative	.06	-.01	.28**	--	--
Human Positive	-.04	.02	-.03	.28**	--
Human Negative	.19*	.18*	-.03	-.02	.16

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 2. *Hierarchical Regression Coefficients for Overall Cognitive Flexibility Task Switch Costs and Affective Flexibility Task Specific Switch Costs Predicting Sad Mood Measures*

Regressions and Variables	sr^2	β	F	ΔF	R^2	ΔR^2
Sad Mood Scale						
Step 1			.14	.14	.001	.001
CF Switch Costs	-.06	-.06				
Step 2			2.34	4.53*	.04	.04
AF SC Human Neg	.19	.20*				
Sad Mood Controlling for Baseline						
Step 1			.40	.40	.004	.004
CF Switch Costs	-.08	-.08				
Step 2			2.32	4.24*	.04	.04
AF SC Human Neg	.19	.19*				

* $p < .05$

Table 3. *Hierarchical Regression Coefficients for Affective Flexibility Task Specific Switch Costs Predicting Sad Mood Measures, Controlling for Overall Cognitive Flexibility Task Switch Costs, Neuroticism, and Symptoms of Depression*

Regressions and Variables	sr^2	β	F	ΔF	R^2	ΔR^2
Sad Mood Scale						
Step 1			3.40*	3.40*	.09	.09
CF Switch Costs	-.10	-.10				
Neuroticism	.12	.14				
CES-D Score	.13	.16				
Step 2			3.40*	3.17	.11	.03
AF SC Human Neg	.17	.17†				
Sad Mood Controlling for Baseline						
Step 1			1.03	1.03	.03	.03
CF Switch Costs	-.09	-.09				
Neuroticism	.13	.16				
CES-D Score	-.19	-.24*				
Step 2			2.14†	5.32*	.08	.05
AF SC Human Neg	.22	.22*				

* $p < .05$, † $p \leq .08$

Appendix

Emotion Regulation Follow-Up Questionnaire

During this study we asked you to watch an emotional film clip. We also asked you to watch this clip in different ways; such as in a way that brings about the LEAST emotion, or to watch the film normally, as you would at home or in a movie theater.
We are interested in understanding the amount of emotion you felt during this film clip.

1. Please circle any cues that you received while watching the film clip:

View Normally **Decrease Emotion**

2. Did you read anything in the instructions indicating that decreasing emotions during the film may be difficult? __________________

IF YES, please paraphrase what you saw:

____

____

____

____

3. On a scale of 1 (not at all) to 7 (very much), how difficult did you expect that decreasing emotions in the film would be for you? ______________________

Please continue on the other side

4. When you were asked to watch the sad film clip normally, what did you do while watching this film clip?

____

____

____

On a scale of 1 (least emotion) to 7 (most emotion), how much sadness did you feel during this time? _______________

5. When you were asked to watch the sad film clip in a way that brought about the least emotion, what did you do while watching this film clip in order to feel LESS emotion?

____

____

____

On a scale of 1 (not at all successful) to 5 (very successful), how successful were you at feeling LESS emotion? ________________

On a scale of 1 (least emotion) to 7 (most emotion), how much sadness did you feel during this time? _______________