Cognitive Control and Emotion Regulation: Effort, Efficacy, and Choice

By

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Abstract

Regulating our emotions in an adaptive way is important for our well-being and social relationships and is thought to be related to cognitive control, which is our ability to act in a goal-directed manner. For instance, the dual mechanisms of control (DMC) framework is proposed as one way to categorize and understand emotion regulation. This research aimed at discerning differences in emotion regulation efficacy and choice through the two modes of cognitive control in the DMC framework. Two experiments were conducted to test the hypotheses that emotion regulation is more effective in proactive contexts compared to reactive contexts overall, and that individuals will choose to use certain emotion regulation strategies more when they are in a proactive context compared to reactive and others in reactive versus proactive. Understanding the temporal dynamics of emotion regulation will benefit the scientific community, in terms of elucidating the theoretical mechanisms underlying emotion regulation, and potentially help inform therapeutic interventions for individuals with emotion regulation difficulties. Experiment 1 demonstrated some evidence suggesting emotion regulation is more effective in proactive conditions but did not provide support for our interaction hypotheses regarding specific strategies in proactive versus reactive contexts. Experiment 2 did not replicate the effect of proactive emotion regulation being better than reactive emotion regulation, and further suggested that strategy choice was not influenced by proactive versus reactive contexts. I discuss the implications of my results, limitations of the current study, and provide suggestions for future research.

Keywords: cognitive control, emotion regulation, dual-mechanisms, temporal dynamics

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Interest in emotion regulation, the ability to control how you experience and express emotions, has a long history (Gross, 2002; McRae & Gross, 2020). Today, the underlying mechanisms of emotion regulation are of concern not only to clinical psychology, because of the significant impact emotion regulation can have on our well-being (Gross, 2002), but also cognitive psychologists, because the cognitive processes required for regulating emotion may also be used for regulating goal-directed behaviour or cognitive control (Ochsner et al., 2004). The connection between cognitive control and the successful regulation of emotion has gained traction in the cognitive and affective sciences community in recent years (Goldin et al., 2008; Martins-Klein et al., 2020; Wang et al., 2022). As such, researchers have posited that theoretical frameworks of cognitive control can be applied to, and explain, successful emotion regulation (Martins-Klein et al., 2020). The dual-mechanisms of control framework, for example, posits proactive (sustained, anticipatory) and reactive (transient, stimulus-driven) modes of cognitive control. This framework is suggested to be a useful approach to apply to emotion regulation, because it can be used to make explicit and formal hypotheses regarding underlying mechanisms of emotion regulation (Martins-Klein et al., 2020). Also, due to their shared features of being a cognitive function that unfolds over time and is temporally dynamic (i.e., process model of emotion regulation; Gross, 1998b), cognitive control through the perspective of dual-mechanisms may provide one way to differentiate between different modes of emotion regulation or demonstrate the “potential adaptive value” of reactive modes of emotion regulation (Martins-Klein et al., 2020, p. 90). Recently, arguments for nuanced understandings of the efficacy of emotion regulation have been called for (Sheppes, 2020).

In the current study, I applied the dual mechanisms of control framework to test the influence of proactive and reactive contexts on emotion regulation in terms of strategy choice, effort, and efficacy. That is, I examined which strategies individuals chose to regulate their emotions (Gross & John, 2003), how often they implemented them (Benson et al., 2019), how difficult they felt to implement (Sheppes & Meiran, 2008), as well as how effective they were at changing the emotional experience (Malooly et al., 2013). Theoretically, if the frameworks used to understand cognitive control can be employed to investigate these factors, this would further our understanding of individual differences in emotion regulation. In turn, this could inform updated clinical theories that benefit individuals who have difficulties in emotion regulation and/or cognitive control and better understand maladaptive emotion regulation (Martins-Klein et al., 2020). First, I will provide a review of emotion, emotion regulation, and cognitive control, and point out research that explores how the latter two may be highly intertwined and rely on the same cognitive mechanisms.

Emotion

Emotions can be defined as the internal feelings we experience and how we express them externally. This definition, however, overlooks some fundamental principles. For instance, it fails to address the features that characterize an emotion including its physiological correlates, and the underlying mechanisms that generate it. Gross (1998b) reviewed a variety of past and contemporary definitions and understandings of emotion, which together suggest that emotions are a response tendency (first proposed by James, 1948), that occur sequentially (Barrett et al., 2007), are flexible, and are provoked when the situation at hand is deemed as important. Another way to characterize emotion is to describe its core features or processes. Gross (2014) summarizes what they believe to be the core features of emotion, namely that they occur in

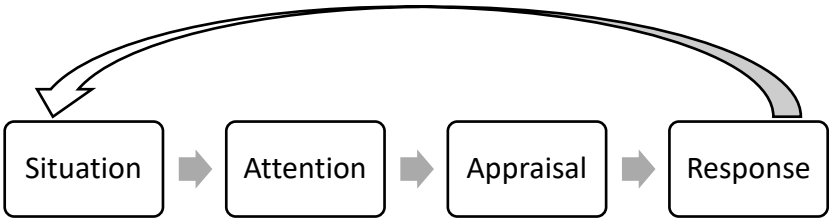
response to an evaluation or appraisal of an internal or external situation, and that they are multifaceted, meaning they involve changes in a few domains such as behaviour, subjective experience, and physiology (e.g., changes in heart rate, skin conductance, brain activity). While there is an argument for the idea that feeling emotions can worsen performance on certain cognitive tasks, or influence/bias our decision-making, they are not inherently maladaptive. Emotions can help guide our behaviours in light of what is deemed relevant or important in a given situation. For example, feeling fear when you see a large or threatening animal could induce your flight response, causing you to seek shelter and evade being detected or attacked by said animal.

Another important aspect of emotion(s) is how they are generated. The modal model of emotion suggests that there is a sequential and looping nature to how emotions are generated. This loop starts with the occurrence of a situation, then attendance to the situation, then evaluating it within the context of some goal, and finally responding to said evaluations (Barrett et al., 2007; Gross, 2014). The responses come in a variety of modalities, such as changes in physiology (e.g., increased heart rate, sweating), changes in behaviour (e.g., avoiding a situation, crying, yelling), and changes in experience (e.g., feeling more or less angry; Gross, 2014). The modal model highlights the temporal dynamics of emotion generation, positing that as emotions are generated, they become more intense. That is, emotion generation builds over time and emotional responses become increasingly heightened the longer they are experienced (Sheppes & Gross, 2011). The temporal dynamics of emotion generation may be a critical factor in determining the success of emotion regulation, because, depending on when in the generation of an emotion you try to regulate, it can be more or less difficult to do so successfully. Lastly, the modal model of emotion proposes that emotion can be circular: the final stage of the process (the

response) can subsequently influence the situation that gave rise to the response in the first place (Gross, 2014). See Figure 1 below for a visualization of the model and this idea.

Figure 1

The Modal Model of Emotion



Note. Adapted from Gross (2014).

Lastly, emotions are typically categorized along theoretically meaningful dimensions. One framework categorizing specific emotions, for instance, is the arousal-valence model of emotions (Russell, 1979). Valence and arousal are designated as the *x* and *y* variables respectively on a two-dimensional grid, and emotions are plotted based on their degree of pleasant or unpleasantness (*x*) and their degree of arousal (*y*), either high or low. Generally, this is a widely-accepted model (although see Bakker et al., 2014). The relevance of this model becomes apparent when we consider how our ability to regulate our emotions can depend on the nature of the emotion (see section "Factors Influencing Emotion Regulation Success"). This model was also important to consider when choosing the stimuli of my experiment and controlling for any possible effect that differences in arousal or valence could have on our outcome measure.

Emotion Regulation

While at one point we may have thought that emotions were something out of our control (Gross & John, 2003; Solomon, 1976), today it is well-accepted that emotions can be regulated or changed (Gross, 2002). As mentioned by Gross (2002), just because we experience an emotion, does not mean we have to act upon its advice. The importance of successfully regulating our emotions can be understood when it is framed in the context of its general influence on our lives. A major (and perhaps obvious) aspect of experience that greatly depends on emotion regulation is our affective experience (Gross, 2002). For instance, anecdotally you may recall a day at work where you were late or spilled coffee on yourself causing mild frustration, anger, or anxiety. Such experiences can easily spin out of control and become overwhelming. However, in this instance, perhaps you reminded yourself that this is but a minor setback in the grand scheme of things— hardly worth troubling yourself over. As a result, your emotional experience was likely less intense, short-lived, and not expressed externally. Experientially then, how we regulate our emotions impacts the amount, duration, and intensity of negative and positive emotional experiences we have, and behaviourally emotion regulation can affect the extent to which we express or inhibit our positive and negative emotions and how we act upon them (Gross 2002).

In addition to affective experiences and behavioural responding, how we regulate our emotions can have important consequences for our social lives and interactions (Gross, 2002), personal relationships, and well-being (Gross & John, 2003). Kalisch (2009) suggests that being able to exert control on our emotional experiences is not only relevant to general quality of life, but also that there are clinical implications, such as serving as a protective factor against the development of psychopathologies whose core symptomology involves difficulties with emotion regulation. However, there has also been concern in the past for the potential negative effects of

emotion regulation on physical health. Some research has suggested that the suppression or restraint (control) of emotions can lead to activation of the sympathetic cardiovascular system, which is an issue given that this can be physiologically costly (Gross & Levenson, 1997). Now that the importance of emotion regulation has been established, I next discuss the frameworks that have been proposed to help understand emotion regulation as a cognitive process.

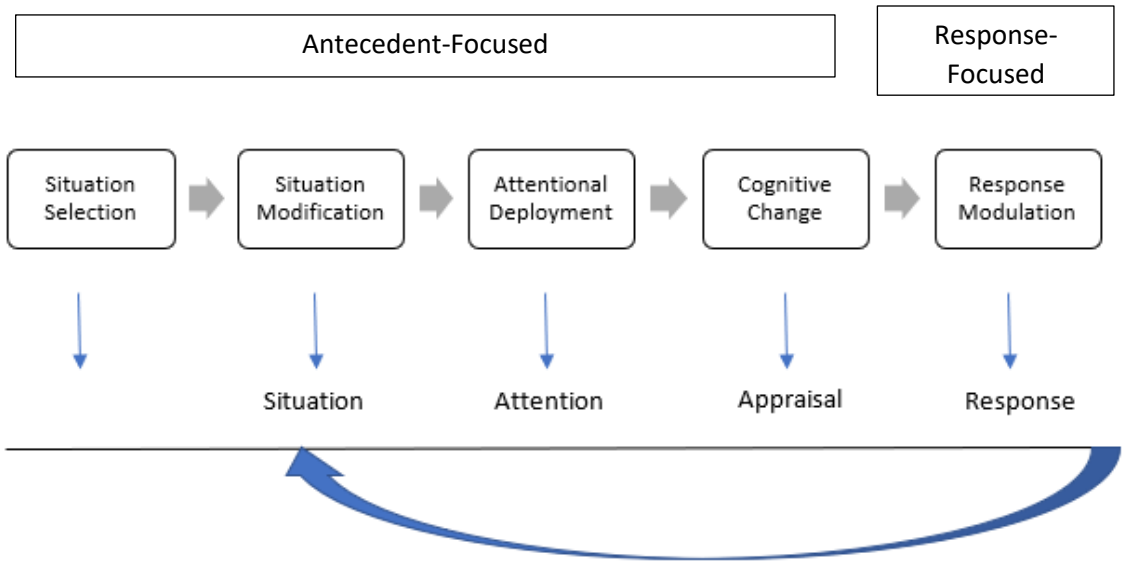
One distinguished working definition of emotion regulation comes from Gross (1998b). Emotion regulation is understood as having the potential to change the way we experience and express our emotions, using a variety of strategies that have different benefits and consequences (Gross, 1998b). There are three main features of emotion regulation (Gross, 2014), the first being the goal which refers to the specific aim of regulating the emotion. For example, your goal could be to reduce the emotional intensity of a negative emotional experience. The second is the strategy which refers to the specific set of goal-directed behaviours enacted to regulate the emotion. Lastly is the outcome which is the result of the emotion regulation strategy in relation to the goal, which can be either experiential (for example a decrease in negative emotion) or behavioural (for example not expressing your emotions outwardly). For the purposes of this study, this working definition provides a good starting place from which to understand emotion regulation.

Emotion regulation can be further understood in terms of the processes involved in selecting strategies and successfully implementing them. The process model of emotion regulation (Gross, 1998b) is an information processing model, and purports to explain how and when emotion regulation strategies are selected and implemented, and when they are effective. Premised on the modal model of emotion (Barrett et al., 2007), the process model of emotion regulation suggests that we can regulate our emotions at each of the four points in the emotion

generation process, specifically at the situation, attention, appraisal, and response points of generating an emotion (Gross, 2014). The process model outlines five families of emotion regulation strategies, which are superseded by the antecedent- and response- focused dichotomy of emotion regulation strategies. Antecedent-focused occurs prior to the emotional response and can involve avoiding or changing a situation or re-evaluating the emotion-eliciting stimuli in question. The antecedent-focused strategy families are (1) situation selection, (2) situation modification, (3) attentional deployment, and (4) cognitive change. Response-focused occurs after the emotional response has started to unfold and involves trying to diminish said response (Gross, 1998a). There is one family in the response-focused strategy category, namely response modulation. It is imperative to note that the differences between the families of strategies here is *when* in the generation of an emotion the strategy is enacted. Figure 2 illustrates the temporal continuum of emotion regulation strategies relative to the generation of an emotion. Strategies that occur early in relation to emotion generation begin on the left side, while strategies that occur later in the emotion generation process are further right (Gross, 2014). The last nuance of the process model of emotion regulation to consider is that because emotion generation can have a circular nature, the emotion regulation process is dynamic, where one phase in emotion regulation can influence another point of emotion regulation via feedback (hence the arrow that points back from the end of the time continuum in Figure 2; Gross, 2014). We can further differentiate within each family of strategies by looking at which strategies fall into each family.

Figure 2

Families of Emotion Regulation Strategies According to the Process Model



Note. Adapted from Gross (2014).

The five families have specific strategies within them, each with their own benefits and consequences**.** Typically, antecedent-focused strategies appear to be the "good" or adaptive form of emotion regulation, because of their ability to diminish subjective ratings of negative feelings (Gross, 1998a). Response-focused strategies appear to be the "bad" or maladaptive form of emotion regulation, because of the associated increase in sympathetic nervous system activation and lesser effectiveness in altering emotional experience (Gross, 1998a). Using a disgust-eliciting film, Gross (1998a) observed that participants who were instructed to use an antecedent strategy reported fewer disgust feelings while watching the film, compared to those who we instructed to use a response-focused strategy. However, this finding is not universal, and some have suggested that this dichotomy is insufficient to understand nuances of emotion regulation success.

Although the antecedent and response-focused dichotomy provides a simple way to understand emotion regulation, recent research suggests that the effectiveness of antecedent-focused strategies versus response-focused strategies may vary depending on the context (see Webb et al., 2012 for a meta-analysis). Some underlying mechanisms may influence emotion regulation effectiveness, such as the type of process involved in regulating the emotion (Webb et al., 2012). For instance, based on their meta-analysis, Webb et al. (2012) found that cognitive change (an antecedent-focused strategy) was more effective at regulating emotion than attentional deployment (another antecedent-focused strategy) and response modulation (response-focused strategy). This suggests that categorizing all antecedent-focused strategies as "good" and all response-focused strategies as "bad" may be an overgeneralization. Another factor to consider is the outcome of the emotion regulation. Webb et al. note that when considering behavioural outcomes, cognitive change was less effective than response modulation, but when considering self-report measures, cognitive change was more effective than attentional deployment. Interestingly, the direction that the emotion regulation effort is employed (i.e., trying to reduce the emotion or trying to increase the emotion), influences it effectiveness. Webb et al. found that effect sizes were greater when the goal of regulating the emotion was contra-hedonic, such as decreasing a positive emotion or increasing a negative one.

Another assumption of Gross' (1998b) conceptualization of emotion regulation being challenged recently is that specific strategies can only occur at certain points in the generation of an emotion. Martins-Klein et al. (2020) suggested that any strategy can be used at any phase during the generation of an emotion. For example, reappraisal is an emotion regulation strategy that would typically occur earlier in the process of emotion generation, prior to an emotion being

fully generated (Goldin et al., 2008). However, Martins-Klein et al. proposed that reappraisal could be initiated reactively, after the emotion has begun to generate.

In summary, emotions can be changed using a cognitive process called emotion regulation. This cognitive process involves attempts to change emotional experiences or expressions, and affective scientists have commonly used Gross' (1998b) process model to study individual differences in emotion regulation effectiveness. However, growing literature has suggested that this model does not fully explain differences in emotion regulation success, and new ideas/models have been proposed to account for this. Given the importance of regulating emotions, I will next review what factors can influence emotion regulation success in general, and what influences specific strategies of interest for the present research.

Factors Influencing Emotion Regulation Success

The success of emotion regulation is often thought to be influenced by how arousing/intense the emotional experience is (Sheppes et al., 2014, study 2) and the valence of the elicited emotion (how positive or negative a stimulus is; Gross & Levenson, 1997). For example, suppression has been shown to decrease emotional experiences of positive emotions but not negative emotions (Gross & Levenson, 1997), and distraction (an emotion regulation strategy) is observed as more effective at modulating emotional experiences in high intensity situations compared to reappraisal (Shafir et al., 2015). However, this result is not supported across the board; more recent work suggests that in healthy (Langeslag & Surti, 2017) and clinical populations (Fitzpatrick & Kuo, 2016), the effectiveness of emotion regulation does not vary based on arousal/intensity. The effect of valence on emotion regulation success seems to be disputable as well. Krause-Utz et al. (2019) found that emotional reactivity (the extent that you feel an emotion) was not influenced by the valence of the stimulus presented. However, Webb et

al. (2012) found that positive emotions were more effectively attenuated via emotion regulation compared to neutral and negative emotions. Therefore, the literature suggests mixed evidence regarding the influence of arousal/intensity on successful emotion regulation.

The efficacy of emotion regulation may also depend on choosing the appropriate moment to implement the strategy. The generic timing hypothesis (Sheppes & Gross, 2011), for instance, suggests that emotion regulation occurring early in the emotion generative process is more effective and less effortful, compared to emotion regulation occurring later in the emotion generation process when the emotional response has already happened. One suggestion for why this is the case is because of the associated emotional intensity during the generation of emotion (Sheppes & Gross, 2011). This means that as an emotion generates (over time) it becomes more intense and thus more difficult to regulate (i.e., the intensity of the emotional experience is relatively low at the beginning of the emotion generation process relative to the end). If the point in time of emotion generation corresponds to how intense the emotion is, findings on emotion regulation success and choice based on the intensity of a situation may provide a foundation to form hypotheses about emotion regulation based on time course. Next, I discuss the findings on how effective reappraisal and suppression are, as well as what factors influence their success specifically.

Reappraisal

Reappraisal entails evaluating the current or future situation or stimuli that is eliciting the emotion and trying to reinterpret it an unemotional way (Gross, 1998a). To engage in reappraisal, participants are typically instructed to think about the emotion eliciting stimuli in a different way, so that it is less emotional (e.g., seeing an injured person and thinking that help will arrive soon; Herrera et al., 2024). Overall, reappraisal is considered to be a high-effort

strategy that requires substantial cognitive resources (Sheppes & Meiran, 2008), such as working memory (Opitz et al., 2014), attention, and cognitive control (McRae et al., 2012). As mentioned previously, reappraisal is a favoured emotion regulation strategy because of how robustly it seems to effectively modulate emotion. A meta-analysis found that, collapsing across 190 studies, reappraisal positively impacts emotional experience, both when reappraising the stimulus itself (d = 0.36) and when reappraising the context of the emotional experience (i.e., changing perspective; d = 0.45; Webb et al., 2012). However, reappraisal had no consistent effect on physiological outcomes (Webb et al., 2012), which is in contrast to a more recent study which found that reappraisal can minimize amygdala responses to a stimuli, even after a 1 week delay (Denny et al., 2015). To add to the uncertainty, one study found that regulating negative emotions using reappraisal was only more effective compared to distraction if the negative emotion was of medium and not high arousal (Shafir et al., 2015), suggesting that reappraisal may not always be more effective than other strategies.

The inconsistency in the efficacy of reappraisal could be attributed to the amount of time an individual has available to engage in emotion regulation. According to Kalokerinos et al. (2017), reappraisal is only effective when there is sufficient time to implement it. However, there may be other factors such as the amount of effort that is required when using reappraisal. Sheppes and Meiran (2008) found that reappraisal results in a significant usage of self-control resources and can worsen cognition. Perhaps because reappraisal is a high effort strategy, we see inconsistencies in its efficacy because not all participants will exert the same effort. In the context of being able to choose which emotion regulation strategy will be used, Herrera et al. (2024) observed that between reappraisal, distraction, none (no emotion regulation), or other (an emotion regulation strategy other than the ones listed), participants chose reappraisal 46% of the

time. Clinical (Hay et al., 2015) and healthy (Sheppes et al., 2011) populations have demonstrated to choose reappraisal more often when the stimulus is of low intensity compared to high intensity. Therefore, exploring reappraisal through the cognitive control lens may show more nuances of when reappraisal is effective and when individuals choose to use it.

Suppression

Suppression is an emotion regulation strategy that focuses on decreasing emotional expressivity (e.g., external reactivity or behavioural display of one's feelings). To engage in suppression, participants are typically instructed to not let their feelings "show", such that if someone were watching them, they could not tell whether or not they were feeling an emotion (Gross & Levenson, 1997). While watching disgust-eliciting films, participants who were instructed to use suppression exhibited less intense visible reactions to the film compared to participants who used reappraisal as an ER strategy (Gross, 1998a). Another study, using startle eyeblinks and facial muscle activity as measures of emotional response, found that suppression led to lesser facial muscle activity and smaller startle eyeblinks (Jackson et al., 2000). While hiding expressivity seems to be a benefit of suppression, the same can not be said for subjective experiences of emotion. In the same experiment, Gross (1998a) found that, compared to watch participants (those who just watched the film and were given no instruction to regulate) and reappraisal participants, participants using suppression had greater subjective feelings of negativity. This finding has been replicated across many studies as indicated by a meta-analysis (Webb et al., 2012). Across 190 studies, suppression was able to decrease emotional expressivity (d = 0.97), but did not consistently attenuate emotional experiences, and in fact led to increased physiological responses (d = -0.22). However, there is some reason to believe that suppression may not be inherently maladaptive. One study found that greater expression of anger

(via facial expression) in bereaved individuals predicted higher grief and worse health after more than a year after they experienced the initial loss of a loved one (Bonanno & Keltner, 1997), suggesting that expressing emotion is not always adaptive. Another perspective is that adaptive emotion regulation is characterized by the flexible use of multiple strategies. One study found that flexibly enhancing and suppressing the expression of emotion can predict levels of distress, where individuals who were better at both increasing and decreasing expressions had lower levels of distress (Bonanno et al., 2004).

In summary, emotion regulation is thought to be a cognitive process that can be more or less effective depending on emotional intensity, the amount of time given to regulate, and how much effort is necessary to use a given strategy. Overall, it seems that reappraisal may be the more 'adaptive' form of emotion regulation given its association with benefitting emotional experiences and suppression may be the 'maladaptive' strategy since it doesn't appear to change emotional experiences. However, a deeper and more nuanced understanding of emotion regulation is necessary to further understand why there are mixed findings regarding the efficacy of some strategies, for example considering arousal, valence, or context.

Emotion Regulation Choice

Another interesting avenue in emotion regulation research looks at how individuals choose to regulate their emotions when given the choice. Sheppes (2014) defines emotion regulation choice as the way that an individual selects among several regulatory strategies to try to change their feelings or emotions, given contextual factors and assuming more than one strategy option is viable. Adaptive emotion regulation choice is important for healthy functioning given that different strategies have different consequences and are associated with various outcomes (e.g., as mentioned prior, certain strategies are thought to be "maladaptive" and are

associated with psychopathology; Gross, 2002). Because of the inconsistency of findings regarding which strategies are adaptive versus maladaptive, some have proposed that context is an important factor to consider when looking at the effectiveness of different strategies (Aldao, 2013). Therefore, Bonanno et al. (2004) argues that adaptive emotion regulation involves choosing among several strategies, while considering factors such as context, and this is why emotion regulation choice is important and interesting to study.

Sheppes et al. (2013) proposed that emotion regulation choice is determined in part by the costs and benefits associated with each strategy. In their framework, they contrast early disengagement strategies (where you don't engage or work with the emotional information to avoid having it represented in working memory) from late engagement strategies (where you engage with the emotional information to change its meaning). They suggest that when emotional intensity is high (more arousing images for example) participants choose to use an early disengagement strategy. When emotional intensity is low (images that are less arousing for example) participants choose to use a late engagement strategy. Generally speaking, using early disengagement in high emotional intensity but not low intensity situations is effective, and using late disengagement in low emotional intensity situations but not high intensity situations is effective (Sheppes & Meiran, 2007). Therefore, early engagement strategies are emotionally beneficial in low intensity situations and late disengagement strategies are emotionally beneficial in high intensity situations. However, just because a given emotion regulation strategy is the most effective in a specific context, it is not guaranteed that people choose to use said strategy, and furthermore, it is not the only factor that determines emotion regulation choice. Below I review several other determinants of emotion regulation choice beyond what is the most effective for differing emotional intensities.

Cognitive Determinants. Regulating emotions can be demanding of cognitive resources given that it is a complex action involving several processes (i.e., generating the strategy, implementing it, and continually using it; Kalisch, 2009; Ochsner & Gross, 2008). For example, reappraisal is a cognitively complex strategy because the person using reappraisal has to work with the emotional information to produce a new interpretation of said information, and because the new interpretation has to then compete with the existing appraisal of the emotional information (Sheppes et al., 2013). Sheppes et al. (2013) contrast reappraisal with distraction, which involves producing new, unrelated, information that can direct attention away from the emotional stimulus. Distraction does not involve working with or reinterpreting the emotional information and is therefore a less complex strategy. Depending on the level of complexity of a given strategy, people may choose to use one strategy over another (Sheppes, 2014). This idea is supported by evidence that when reappraisal is simplified (by providing concrete instructions of how to use reappraisal) it is more often chosen (about 10% more) compared to when participants are simply told to use reappraisal (and therefore have to come up with their own idea of how to reappraise).

Effort. Emotion regulation strategies require differing levels of effort, for example reappraisal is thought to require high levels of effort (Strauss et al., 2016), and down regulating emotions tends to be more difficult than upregulating them (Ochsner et al., 2004). Is the level of effort required to use an emotion regulation strategy indicative of whether or not a given strategy will be chosen? According to Sheppes et al. (2013) participants (counterintuitively) choose to use more effortful strategies under high emotional intensity conditions compared to low intensity conditions. Milyavsky et al. (2019) investigated the influence of high and low cognitive effort conditions on participants choice to use reappraisal or to look at an image. Participants had to

first predict which strategies other participants would use based on each emotional image (low effort condition), and in the second block had to choose a strategy to use and implement it themselves (high effort condition). They found that participants chose to reappraise more so when cognitive effort was low compared to when cognitive effort was high.

When viable, individuals can choose to regulate their emotions using one of many strategies, and adaptive regulation choice is thought to consist of flexibly choosing between different strategies based on several factors. These factors include but are not limited to how intense the emotion is, what cognitive resources an individual has, the processes underlying them, as well as the level of effort associated with a given strategy. However, in my review of the literature, the majority of studies contrast participants choice of reappraisal versus distraction, rather than reappraisal versus suppression. Some studies that have looked at the differences in peoples choices to use suppression versus reappraisal have typically only focused on differences between people with a disorder of some type versus healthy individuals. Schnabel et al. (2022) found that both healthy individuals and individuals with somatic symptom disorder used reappraisal 53.93% of the time and 51.14% of the time respectively, suggesting that there was no difference in how often participants chose to use one strategy versus the other. Joormann and Tanovic (2015) found that individuals with depression spontaneously use suppression more so than healthy individuals do, but that there was no difference between the groups in choosing to use reappraisal. Sheppes (2014) support my review of the literature and note that research on emotion regulation typically only involves looking at reappraisal and distraction (because they fit well within the framework proposed by Sheppes et al. [2013]), and that future research should investigate how people choose to use so-called maladaptive strategies such as suppression. This is a notable research gap in the emotion regulation literature given that suppression has been

cited canonically as the maladaptive strategy, yet there are few investigations looking at whether and to what degree an average person makes use of suppression.

Cognitive Control

Cognitive control refers to the set of processes that enable goal-directed behaviour (Braver, 2012). Cognitive control is an umbrella term that describes the processes that allow us to decide what we are thinking about, select and manipulate information mentally (i.e., working memory; Braver et al., 2008), inhibit automatic responses, and resolve response interference (Miyake et al., 2000). Importantly, cognitive control can be flexible in that it adapts and changes fluidly depending on the current goal or task demands (Braver et al., 2008). Another important characteristic of cognitive control is that it is constrained by limitations in mental resources (Feng et al., 2014). In this proposal, I will focus on one recent framework, the dual-mechanisms of cognitive control account, which explains the temporal dynamics of cognitive control in terms of 'proactive' and 'reactive' control processes (Braver et al., 2008).

Dual-Mechanisms of Cognitive Control

The dual-mechanisms of cognitive control framework proposes two separable and antagonistic modes of cognitive control, called proactive and reactive cognitive control, that differ based on temporal dynamics (Braver et al., 2008). Proactive cognitive control has been referred to as a "early selection" mechanism (Braver et al., 2008, p.11), and occurs when we prepare to act, behave, or respond in a certain way prior to exposure to a stimulus. For example, driving to the grocery store and thinking through/planning which items to buy, so as to avoid overspending or browsing the shelves for too long. Reactive cognitive control has been referred to as a "late-correction" mechanism (Braver et al., 2008, p.11) and operates without preparation,

when there is a need to control our thoughts and actions in the moment (often in response to a stimulus). For example, driving home from work and seeing a police car flashing behind you, which leads to you pulling over so that they can drive by. In the most general description, proactive cognitive control is involved prior to an event and reactive cognitive control is involved after an event or spontaneously in reaction to an event (Braver et al., 2008).

The main purpose of the dual mechanisms of cognitive control framework is to distinguish between qualitatively different states of cognitive control. In proactive states, goals are maintained in preparation for potential instances where control will need to be used. In reactive states, control is used only on an as needed basis, being activated when there is detection of a need to use it, and sometimes when goals are reactivated in response to a stimulus (Braver, 2012). Whether one leans into one state versus the other may depend on task demands and individual differences (such as between healthy and clinical populations; Braver, 2012).

It is important to note that each of these states have their own advantages and disadvantages, and it is suggested that there needs to be flexible use of both states to achieve optimal cognitive processing (Braver, 2012). Proactive cognitive control is achieved via several cognitive resources, including using working-memory to continually maintain a goal, planning (working with a goal to plan out future actions), reasoning (weighing and understanding options), and attention (Braver, 2012). In general, proactive cognitive control is advantageous in predictable situations where you know what your course of action needs to be based on a pre-existing understanding of that situation (Braver, 2012). For example, knowing that when you check out at the grocery store they will likely ask if you want bags for your items, and preparing to respond with “no”. However, proactive cognitive control also comes with some disadvantages; it is heavily resource dependent given that the goals have to be continually maintained and

adjusted which can in turn limit the ability to think about something else or to do other tasks (Braver, 2012). Another issue with proactive cognitive control is that it is less flexible in terms of responding to changing demands or contextually relevant cues (Braver, 2012). This could result in responding "no" to the cashier as they ask you how you are doing, because you expected them to ask you if you needed bags.

Reactive cognitive control on the other hand relies on bottom-up triggering (e.g., via an event or stimulus) of a previously determined goal and is "computationally efficient" (Braver, 2012, p. 10), because it only uses cognitive resources as they are needed. Specifically, Braver (2012) explains that reactive cognitive control allows for goals to be activated only on an as-needed basis, which leaves extra cognitive resources up for grabs. Another advantage of reactive cognitive control is its flexibility; it is much more sensitive to environmental changes or potentially relevant contextual cues (Braver, 2012). However, Braver also notes that achieving the goal will then require a stimulus or event to trigger reactivation of said goal. This could result in potentially forgetting an important task goal if the goal is not properly reactivated. Therefore, depending on contextual information, task demands, and available resources, flexibly switching between proactive and reactive forms of cognitive control is optimal for efficient cognitive functioning.

A common task used to demonstrate qualitative differences in cognitive control states is the AX-continuous performance task (AX-CPT; Braver, 2012). The AX-CPT is a modified version of a previously developed task (Rosvold et al., 1956), and is used to measure one cognitive control function, specifically context-processing (Braver et al., 2001). Understanding this task paradigm is especially important for this research, given that the emotion regulation task is an adaptation of it. Gonthier et al. (2016) provide a helpful description of the AX-CPT design.

In an AX-CPT task, participants respond to a probe based on what cue they saw previously. Specifically, an AX-CPT trial starts with presentation of a cue letter (e.g., “A”) followed by a short delay, followed by a probe letter (e.g., “X”). Participants are instructed to make a specific response via a keypress when they see the “AX” letter sequence (i.e., AX trials; Gonthier et al., 2016), and when they see any other letter sequence (e.g., “A” followed by “Y”; AY trials) they are instructed to make a different response via keypress (Gonthier et al., 2016). Depending on the sequence of letters that are presented, participants may benefit from either proactive or reactive cognitive control. In AX trials, proactive cognitive control results in better performance (i.e., faster response times) because proactive control is preparing the participant in advance to make a specific response associated with “A” cues and “X” probes. However, in AY trials, proactive cognitive control results in worse performance (i.e., slower response times and more errors) because participants would likely be preparing to make the response associated with AX trials but must quickly process and resolve interference so that they can make the correct response associated with AY trials. In this case, AY trials would benefit from reactive modes of cognitive control, since the participant would be actively monitoring the stimuli to inform their response (Gonthier et al., 2016). Proactive modes of cognitive control will also result in better performance for BX trials (“B” as the cue and “X” as the probe), given that the “X” will not serve as a “convincing lure” (Gonthier et al., 2016, p. 2) since it was preceded by the cue “B”.

Utilizing the dual-mechanisms of cognitive control framework has proved useful for learning more about intra-individual differences (i.e., differences that result in changes within an individual such as task demands or context; Braver, 2012), and inter-individual differences (i.e., differences that result in changes between individuals, such as working memory capacity or fluid intelligence; Braver, 2012). It has also been helpful in elucidating differences in cognitive

control based on between-group differences (i.e., between populations or groups of people, such as individuals with psychopathology compared to healthy individuals). The dual-mechanisms framework also helps explain temporal dynamics in cognitive control, for example demonstrating differences in brain activity in proactive versus reactive cognitive control tasks (Braver et al., 2009) suggesting that there may be different underlying neural processes. Given that the exact control mechanisms and processes of emotion regulation are currently unknown, the dual-mechanisms framework provides a new way to examine performance differences in regulating emotions, as well as possibly explain why there are heterogenous findings regarding the time-course of brain activity for a single emotion regulation strategy (Martins-Klein et al., 2020).

Emotion Regulation and Cognitive Control

As mentioned before, the affective sciences and cognitive sciences literatures have been largely developed independent of each other, but there has been an increasing number of studies investigating their overlap (e.g., Hendricks & Buchanan, 2016; Joormann & Tanovic, 2015; Martins-Klein et al., 2020; McRae et al., 2012; Ochsner et al., 2012; Pruessner et al., 2020; Wang et al., 2022). For instance, physiological evidence of the overlap between emotion regulation and cognitive control comes from brain imaging data. Ochsner et al. (2004) observed that emotion regulation led to activation of brain regions that are typically associated with cognitive control. Specifically, the anterior cingulate regions and prefrontal regions were recruited during emotion regulation. Behaviourally, working-memory capacity (a cognitive control function) is linked to emotion regulation success; individuals with better working-memory capacity typically have greater success during emotion regulation tasks (McRae et al., 2012; Schmeichel & Tang, 2015b). There is also evidence suggesting that improving working-

memory results in more effective regulation of emotions (Schweizer et al., 2013), possibly implicating that emotion regulation relies heavily on cognitive control processes. Additionally, individuals who experience psychiatric disorders characterized by difficulties in regulating emotions tend to also have deficits in cognitive control functions. For example, major depressive disorder has been associated with greater difficulties in updating contents of working-memory (Joormann et al., 2011), and show greater activity in cognitive control brain regions (compared to controls) when doing an updating task (Foland-Ross et al., 2013).

Emotion regulation requires substantial cognitive resources, since it can involve several mental goals and actions such as trying to reinterpret a situation to make yourself feel better. Some researchers have explored the cognitive costs of emotion regulation. McRae et al. (2012) found that reappraisal was positively correlated with participants ability to switch between different interpretations or understandings of a situation based on emotional stimuli or context. Schmeichel and Tang (2015a) suggest that emotion regulation also relies on individuals' ability to control an automatic or prepotent response or to change the emotion regulation strategy that they automatically default to. Lastly, an individuals ability to change old information with new information in their mind is thought to support emotion regulation by getting rid of emotional information that is deemed irrelevant from working memory and exchanging it with newer, contextually relevant and/or emotionally neutral information (Pruessner et al., 2020). However, it is important to note that these findings are not universal; Pruessner et al. (2020) suggest that there is heterogeneity in studies trying to connect these cognitive abilities to emotion regulation.

Despite the acknowledgement that cognitive control and emotion regulation are related, there is still a notable lack of understanding regarding the exact control processes that emotion regulation uses. Martins-Klein et al. (2020) have proposed characterizing emotion regulation

through the dual-mechanisms perspective of cognitive control (Braver et al., 2008) to help address this gap. By applying this model, they hope to identify the underlying control mechanisms that may explain the differences in regulation efficacy. Martins-Klein et al. go on to note that, at the time of their article, there were no studies applying the dual-mechanisms fully to emotion regulation studies. One review of emotion regulation paradigms (Ochsner et al., 2012) found that the majority of studies (29/43) use proactive cues, while fewer use reactive cues (14/43). Perhaps emotion regulation efficacy not only depends on strategy, valence, or arousal, but also based on whether it is implemented in a proactive or reactive context. If participants are cued ahead of time that they will have to use reappraisal to regulate their emotions for the upcoming stimuli, this might recruit a specific set of processes. For example, participants may be engaging in proactive control to keep the strategy of reappraisal in mind, subsequently enact it when they see the emotion-eliciting stimuli, and continue doing so until the goal of the strategy has been met (Martins-Klein et al., 2020). If participants are cued at the same time as or after the stimulus presentation, this might recruit another specific set of processes. For example, participants may be engaging in reactive control since they now have to try to engage in reappraisal while already having the emotional information represented in their mind, which likely involves overriding the current interpretation of the emotional information with a new neutral interpretation. As a result of distinct control processes, the two cueing times reflecting proactive and reactive control may require different levels of effort, and/or may be more or less effective depending on the strategy that is cued.

Further, while it is acknowledged that emotion regulation choice is influenced by cognitive effort (often used as a proxy for cognitive control; Shepherd, 2022), there seems to be no exploration of the influence of proactive versus reactive contexts on emotion regulation choice

(M. Matthews et al., 2021). One study touched on the subject of cognitive effort and emotion regulation choice (Milyavsky et al. 2019) and found that participants chose reappraisal more often under low cognitive effort compared to high cognitive effort demands. If proactively regulating your emotions is less effortful, then perhaps proactively cueing participants to choose a specific strategy is also less effortful and subsequently results in choosing reappraisal more often. If reactively regulating your emotions is more difficult, then perhaps reactively cueing participants to choose a specific strategy is also more difficult, and therefore results in them choosing to use suppression more often.

These suggestions are, however, purely speculative and theoretical. The mechanisms of proactive and reactive control have yet to be fully explored for emotion regulation efficacy and choice, and so their underlying processes and relative effectiveness are unknown. Therefore, Martins-Klein et al. suggested that comparing both proactive and reactive emotion regulation within the same study may aid in understanding what processes are uniquely involved in proactive versus reactive modes of emotion regulation.

Experiment 1

Past research has shown the temporal characteristics of proactive and reactive cognitive control, but this framework has not been applied to the study of emotion regulation, even though there is clear evidence that emotion regulation is also temporally dynamic and highly correlated with cognitive control. Given the acknowledged connection between cognitive control and emotion regulation, I aimed to investigate the influence of temporal dynamics on emotion regulation effectiveness and emotion regulation difficulty. In Experiment 1, participants completed an emotion regulation task that is inspired by the AX-CPT design, and self-report questionnaires about use of different emotion regulation strategies, mood, and attentional control.

During the emotion regulation task Participants viewed negative and neutral images and were tasked with engaging in either reappraisal or suppression on each trial, with the goal of changing their emotions, and for some trials tasked with simply looking at the image and not trying to change their emotions. Participants reported how difficult it was to use an emotion regulation strategy, and how negative they felt at the end of each trial. Critically, I manipulated the timing on each trial, such that on 'proactive' trials, participants were cued with time to prepare the emotion regulation strategy prior to the stimulus onset and on 'reactive' trials, participants were given the strategy and stimulus simultaneously.

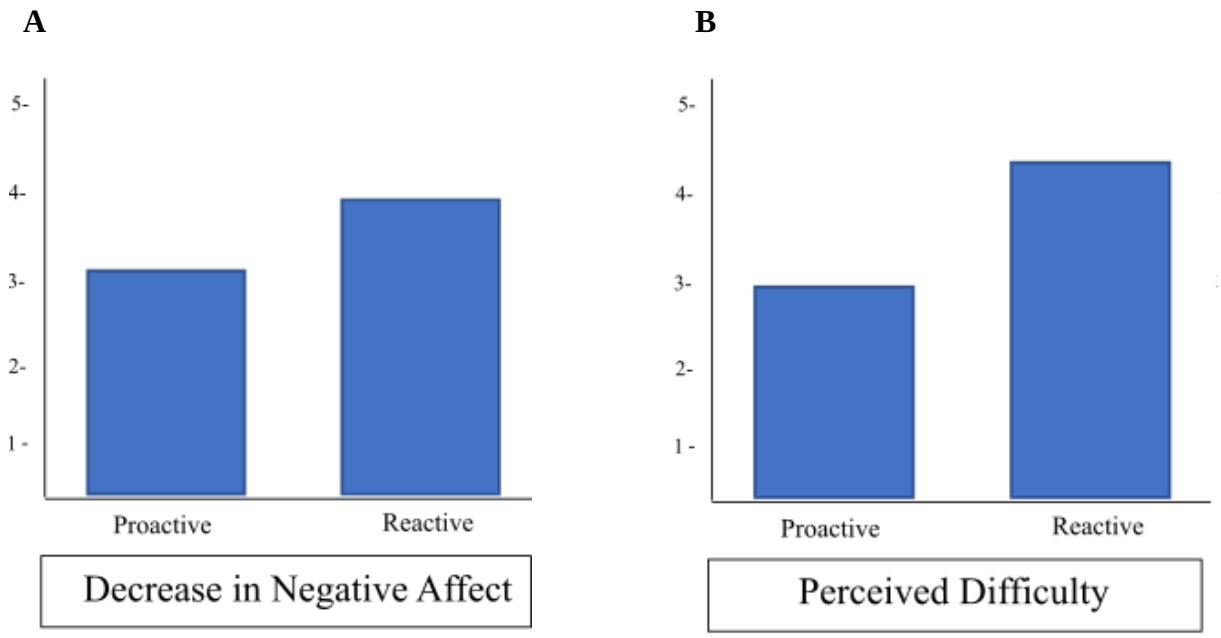
Hypotheses

Behavioural

I hypothesized that participants would have greater feelings of negativity when cued reactively to regulate their emotions and lesser when cued proactively (Figure 3b). I also hypothesized a two-way interaction, whereby reappraisal would be more effective (indicated by lower feelings of negativity) than suppression in the proactive condition, and suppression would be more effective than reappraisal in the reactive condition. I also hypothesized that participants would rate trials where they were cued reactively to regulate their emotions as more difficult then when they were cued proactively (Figure 3a). Further, I hypothesized there would be an interaction between strategy type and condition, such that reappraisal would feel less effortful when cued proactively compared to reactively, and suppression would feel less effortful when cued reactively compared to proactively.

Figure 3

Predicted Results of E1 and E2



Note. In Figure 3A, the x axis represents feelings of negativity. In Figure 3B, the x axis represents how difficult the trial felt.

Questionnaires

Furthermore, I hypothesized that scores on the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003) would correlate with participants ratings of how difficult each strategy is. For example, I expect the subscale of the ERQ for suppression to correlate negatively with ratings of how difficult it felt to use suppression (i.e., participants who report using suppression more will find it less difficult to use suppression in the task; McRae et al., 2012). I also expect that the reappraisal subscale of the ERQ would correlate negatively with ratings of how difficult reappraisal is to use. Lastly, I hypothesized that scores on the Positive and Negative Affective Schedule (PANAS; Watson et al., 1988) would correlate with participants ratings of how

effective emotion regulation strategies are. Specifically, I predicted that the negative subscale of the PANAS will positively correlate with participants ratings of how negative they felt (i.e., the more negative they report feeling on the PANAS the higher their ratings of negativity during the emotion regulation task). I also expect that the positive subscale of the PANAS will negatively correlate with participants ratings of how negative they felt during trials in the emotion regulation task. Exploratorily, I included the Attentional Control Scale (Fajkowska & Derryberry, 2010), the Attention Control Scale: Distracting and Shifting (Franklin et al., 2014), and the NASA Task Load Index (Hart & Staveland, 1988).

Method

Participants

Inclusion and Exclusion. Participants were recruited from the University of Manitoba's online Sona-system. The inclusion criteria were adults ages 18 years or older, English as a first language, and must not have participated in Experiment 2. Participants were excluded if they were not 18 years of age or older or if their first language was not English.

Sample and Sample Size Justification. Sample size determination was done a priori using the RStudio (Version 4.2.2) package called Superpower for power analysis of factorial designs via simulated data. The first power analysis consisted of a 2 x 3 within-subjects design to determine how many participants were needed to detect differences in strategy efficacy depending on strategy and timing. The second power analysis consisted of a 2 x 3 x 2 within-subjects design to determine how many participants were needed to detect differences in strategy efficacy depending on strategy, timing, and valence. Means, correlations, and standard deviations were chosen based on past research that looked at differences in the efficacy of ER strategies on

reducing negative affect (Herrera et al., n.d.; Jackson et al., 2000; Webb et al., 2012) and are provided in Appendix A. suggests that for an ANOVA, a small effect size is $d = 0.10$, medium effect size is $d = 0.25$, and large effect size is $d = 0.40$. Based on the first power analysis of the 2 x 3 design, I determined at least $n = 50$ participants were needed to have 82.9% power to detect a small effect size ($d = 0.11$), and at least $n = 30$ participants to have 97.1% power to detect a medium effect size ($d = 0.26$). Based on the second power analysis of the 2 x 3 x 2 design, I determined that at least $n = 55$ participants were needed to have 84.1% power to detect a small effect size ($d = .10$), and at least $n = 35$ to have 98% power to detect a medium effect size ($d = .247$). Based on these power analyses, I planned to recruit $n = 100$ participants to ensure that even after data cleaning and deletion, I have sufficient power to conduct my statistical analyses.

Emotion Regulation Task

Emotion Inducing Images. Emotion was induced using images taken from the Nencki Affective Picture System (NAPS; Marchewka et al., 2014). NAPS provides ratings on arousal, valence, approach-avoidance, and several other characteristics of 1356 images, based on a study with 204 participants who rated images on a variety of scales/dimensions. The NAPS contains images from five categories, broadly labelled as animals, people, objects, landscapes, and faces. I chose to use the NAPS instead of the popularly used International Affective Picture System (IAPS; Lang et al., 2008), because of the potential disadvantages of the IAPS (see Marchewka et al., 2014 for discussion of this). I created 100 lists of images, each with a total of 120 images, 60 for each of the two blocks, further broken down into 10 negative and 10 neutral for each condition (see Table 1 for conditions).

Emotional images were selected systematically using the LexOps package (Taylor et al., 2020) in R Studio which allows the user to generate stimuli lists from any dataset based on a set

of parameters you provide. Using the criteria listed in Table 2, I wrote an algorithm that takes a set of parameters and selects 60 pairs of images (for 120 total) from the NAPS dataset to meet the constraints of the criteria. First, the algorithm splits images by valence to select one negative (*M* valence = 1.2-2.8) and one neutral (*M* valence = 4-6.2) image. Next, the algorithm controlled for arousal by selecting a negative and neutral image within a specific tolerance (arousal = ± 0.27) indicating that paired images should have an arousal rating not more than 0.27 different than each other. Lastly, image complexity was controlled for in the algorithm by indicating that the pair of images should have similar JPEG size (a proxy of image complexity; Marchewka et al., 2014), within ± 120,000. Out of the 1356 total images, the algorithm included 670 unique images resulting in ~49% of images from the entire NAPS database being used. The original images had minimum resolution of 1,600 x 1200 pixels (Marchewka et al., 2014), but were sized down to be 500 x 500 pixels using an online tool (https://bulkresizephotos.com/en) while maintaining their aspect ratio due to limitations on the ability to upload large files to the server that the experiment was hosted on.

Table 1

Conditions of E1

	Suppress	Reappraise	Watch
Proactive	Negative Neutral	Negative Neutral	Negative Negative
Reactive	Negative Neutral	Negative Neutral	Negative Neutral

Note. Each trial type was completed 10 times in pseudorandomized order.

Table 2

Parameters for Image Selection

Parameter	Range	Values
Valence (split by)	1-9	Negative: 1.2-2.8 Neutral: 4:6.2
Arousal (control for)	1-9	±0.27
Complexity (control for)	102,794-833,739	±120,000

Experimental Design

Task Design. To test the research questions and hypotheses, I employed an experimental design that combines the structure of a well-established cognitive control task with typical emotion regulation paradigms. As mentioned previously, the AX-CPT (Braver et al., 2001) is a cognitive control task used to measure differences in proactive and reactive cognitive control by using early and late cues, respectively. This task has been adapted for emotion regulation studies by replacing the cue and probe letters with strategy cues that appear either before an image (proactive) or at the same time as an image (reactive). The trial structure was adapted from two previous studies on emotion regulation (Herrera et al., 2024; Wang et al., 2022). For proactive trials, each trial started with a fixation cross (1 s), followed by an instructional cue (either "Reappraise", "Suppress", or "Look"; 2 s) which tells them which strategy they had to implement upon seeing the emotional image. Next, a negative or neutral picture was presented for 6 s. During the 6 s period, participants were intended to down-regulate the intensity of their emotion (as per the instructions given prior to beginning the task). After a blank screen delay that lasted 0.5 s, participants were cued to report how negative they felt on a scale of 1 (*not very negative*) to 5 (*very negative*) using the numbers on the keyboard. Upon responding, participants were then prompted to report how difficult the strategy was to use, on a scale of 1 (*not very hard*) to 5 (*very hard*). For the reactive trials, each trial started with a fixation cross (1 s), followed by a

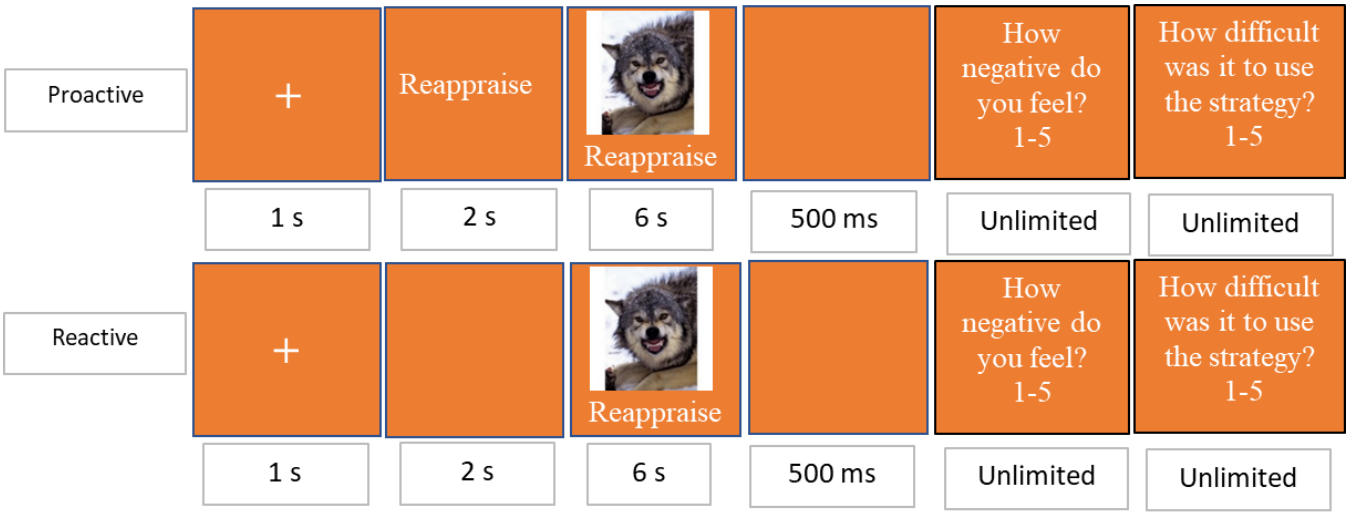
blank filler screen that functions as a placeholder for where the emotion regulation cue would normally be (since in reactive trials they will not know ahead of time which strategy they will have to use; 2 s). Then, an image and one of the three instructional cues (“Reappraise”, “Suppress”, or “Look”) was presented for 6 s, during which the participants are intended to down-regulate the intensity of their emotion (as per the instructions given prior to beginning the task). After a blank screen delay that lasts 0.5 s, participants were cued to report how negative they felt on a scale of 1 (*not very negative*) to 5 (*very negative*) using the numbers on the keyboard. Upon responding, participants were then prompted to report how difficult the strategy was to use, on a scale of 1 (*not very hard*) to 5 (*very hard*)

Each trial lasted for a total of 9 s, plus the amount of time it took participants to report their answers to the two questions (they had unlimited time to answer, but typically took 1-2 s for each question). For a visual representation of the trial structure, see Figure 5. Participants completed two blocks of 60 trials each (120 trials total), with an equal number of trials (10) for all conditions (see Table 1 below). Therefore, the experiments design was within-subjects and fully crossed/balanced. In total, the task blocks lasted ~10 min each. Prior to starting the task, participants completed one practice trial of each condition (12 trials), which should have taken no longer than 2 min. Since this task does not involve any measures of reaction time, the answers on the two scales (how negative they felt and how difficult it was to implement the strategy) were used as a proxy of the efficacy of their emotion regulation. The order that trials appeared in was pseudorandomized (via random number generator in JavaScript). The experiment was programmed using HTML, JavaScript, JavaScript Psych (Version 7.3; Leeuw, 2014), and CSS scripts (provided by jsPsych), and ran on a Microsoft Windows computer. All code can be found

at the Open Science Framework (OSF) website page created for this project (https://osf.io/rwu5g/).

Figure 4

Trial Structure of E1 and E2



Task Instructions. Prior to beginning the task, participants read the instructions, modified from those provided in Herrera et al. (2024) which are adapted from McRae et al. (2012). The modification to the instructions is necessary because Herrera et al.'s study did not use suppression, and so suppression instructions were pulled from the Goldin et al. (2008) study. The instructions tell participants what to do when cued with "Suppress", "Reappraise", or "Look" (see Appendix B for full instructions). The cue "Suppress" is described as trying to hide how you feel, "Reappraise" as changing the way you think about an image to feel less negative, and "Look" as allowing oneself to let feelings arise naturally.

Questionnaires

Positive and Negative Affective Schedule. The Positive and Negative Affective Schedule (PANAS; Watson et al., 1988) consists of two scales (one measuring positive affect the other measuring negative affect) each with 10 items. The purpose of the PANAS is to obtain a brief, accurate, and reliable insight into how participants are feeling at the time of the experiment. Each item is formatted the same only with a different adjective to describe each feeling (e.g., "Indicate to what extent you feel this way right now, that is, at the present moment" along with the adjective "excited"). The PANAS provides a few different options that allow researchers to specify the time frame that they want participants to report on, and for this study the current/in the moment instructions was provided (how they feel right now). Watson et al. (1988) provide validity and reliability of the PANAS scales in their original article, based on data collected on undergraduate students and employees of a university. Overall, Watson et al. report good internal reliability regardless of the time frame participants were reporting on, for both the positive (α = .86-.90) and negative (α = .84-.87) subscales, which suggests that the scale is reliable even between different time instructions. Discriminant validity is reported as very low (*r* -.12 to -.23) suggesting that the two subscales share a minuscule amount of their variance. Please see Appendix C for a copy of the PANAS. Scoring of the PANAS is simple since both subscales have the same number of items; items representing positive emotions are summed together (ranging from 10-50), and items representing negative emotions are summed together (ranging from 10-50).

Emotion Regulation Questionnaire. The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003), measures individuals reported use of two emotion regulation strategies, suppression and reappraisal. The ERQ consists of 10 statements that ask about emotional expression and experience, and participants rate their level of agreement on a scale of 1 (*strongly*

disagree) to 7 (*strongly agree*). For example, "I control my emotions by changing the way I think about the situation I'm in" is an example of a reappraisal question. Scoring of the ERQ is done by averaging each participant's subscale scores (given that the two subscales have an unequal number of items), with a higher mean representing greater use of a given strategy (see Appendix D for reverse scoring of some items). The ERQ demonstrates good psychometric properties. The suppression items and reappraisal items are highly independent (r = -.01), and the average reliability for reappraisal is r = .79 and for suppression is r = .73 (Gross & John, 2003). Lastly, test-retest reliability was sufficient (r = .69). Please see Appendix D for a copy of the ERQ.

Attentional Control Scale. The Attentional Control Scale (ACS; Derryberry & Reed, 2002) measures individual differences in attention, which is thought to be made up of an anterior, proactive system that functions similar to an executive control system where control is voluntary, and a posterior, reactive system that functions automatically in response to stimuli. The ACS consists of 20 statements describing different experiences with concentration, distraction, task switching, among others. Participants had to rate their agreement with each statement on a scale of 1 (*Almost Never*) to 4 (*Always*). For example, "It's very hard for me to concentrate on a difficult task when there are noises around" is the first question in the ACS. Scores can range from 20-80, with a higher score implicating better attention control. Some of the questions are reverse scored to keep in line with this interpretation (see Appendix E for full questionnaire and scoring). Fajkowska and Derryberry (2010) examined the psychometric properties of the ACS in a Polish sample and found that it had moderate reliability (r = .45 - .73) based on a one month follow-up, as well as content and internal validity based on coefficients

(.29 - .63) from item-discrimination analysis. Fajkowska and Derryberry concluded that the ACS is a good scale for measuring general attentional control abilities.

Attentional Control: Distraction and Shifting Scale. The Attentional Control: Distraction and Shifting Scales (ACS-DS; Carriere et al., 2013) measures mind wandering, both spontaneous and deliberate, as well as fidgeting behaviours. The ACS-DS consists of eight statements describing experiences with distraction, concentration, switching between tasks, and fidgeting. For example, "I am slow to switch from one task to another". Participants rate their level of agreement with each statement, from *Almost Never* (1) to *Always* (5). Each subscale is then averaged to produce a mean score for each subscale. The subscales have good internal consistency (α = .809-.822; Carriere et al., 2013). See Appendix F for full questionnaire.

NASA Task Load Index. The NASA Task Load Index (NASA-TLX; Hart & Staveland, 1988) estimates subjective physical and mental effort, perceived temporal demands, feelings of frustration and motivation, and perceived performance, that occur during a task. The index consists of seven questions, for example "How mentally demanding was the task?". Participants provide a rating from 0 (*Very low*) to 100 (*Very high*), indicating the degree of effort, frustration, etc., they felt while completing the emotion regulation task. The only exception to this rating is for the question regarding success during the task, for which they provide a rating from 0 (*Failure*) to 100 (*Success*). Psychometric properties of the scale are good, with high internal consistency (α = .825; Matthews et al., 2015). See Appendix G for full questionnaire.

Procedure

Eligible participants were able to view and sign up for the experiment via the University of Manitoba's Sona-System. Upon seeing the advertisement for the study, they could view and

choose an in-person timeslot to do the experiment. All participation was completed on a desktop computer in a lab room at the University of Manitoba. Upon arrival to the lab, participants first read the consent form (Appendix E) and electronically consented, followed by answering some demographic questions (see Appendix I). Next, they completed a series of questionnaires as mentioned, specifically the ERQ (Gross & John, 2003), the ACS (Derryberry & Reed, 2002), and the ACD (Carriere et al., 2013). Next, participants viewed the task instructions on screen that detailed how the task worked, including what they had to do when cued to "Suppress", "Reappraise", or "Look" (see Appendix E). Participants then completed 12 practice trials. To confirm that they understood the instructions, the principal investigator (or research assistant) asked them to verbally confirm that they understood the task instructions and that they had no questions about how to proceed after completing the practice trials. Once this understanding had been established, they completed the first block of trials (which lasted ~15 minutes) of the emotion regulation task. Participants were then given a 5 min break to rest before the next block of trials. The second block of trials followed the same format as the first block. After finishing the second block of trials, participants completed the PANAS (Watson et al., 1988), then the ERQ again (Gross & John, 2003). Lastly, they were provided with a debriefing letter (see Appendix J) that outlines the purposes of the study and provides information on where they can access mental health resources if they need to. In total, E1 took ~ 60 min to complete. After completing the study, participants were granted two research participation credits towards their introduction to psychology course requirements.

Results

All code is posted on the Open Science Framework (https://osf.io/kv2q8/). E1 was preregistered to follow open science research practices (https://osf.io/8nrqc).

Participant Characteristics and Data Screening

Participants were recruited starting on December 4, 2023, and ended on March 18, 2024. There were 109 sign-ups for my first experiment (E1); out of those, 103 attended their session and were granted credit for participating. All participants consented and none withdrew from the study. A summary of the demographics of participants are provided in Table 5 below. To ensure high quality data, I outlined and preregistered data exclusion criteria based on a previous study using a similar design (Horner et al., 2023). Participants data (both behavioural and questionnaire data) was excluded if (1) not all experimental trials were completed (incomplete data), (2) more than 25% of a participant's responses were >10 s or <300 ms, and (3) if a participant repeated the same response on 30 consecutive questions during the experimental trials. Data cleaning and wrangling were computed via R Studio. Data cleaning resulted in 24 participants being excluded from data analysis, leaving 74 usable participant files.

Table 3

Demographics of Participants in E1

Characteristic	Mean *(SD)*	*N* (%)
Age	20.09 (3.66)	
Gender		
Female		49 (66.2)
Male		24 (32.4)
Prefer not to say		1 (1.4)
Ethnicity		
Black		11 (14.9)
Filipino		7 (9.5)
South Asian		6 (8.1)
White		33 (44.6)

Note. Not all indicated ethnicities are included in this table to provide an overview of the ethnicities in the sample.

Emotion Regulation Task

All statistical analyses were conducted in R Studio. To examine differences in means of emotion regulation effectiveness and effort between proactive versus reactive conditions and between emotion regulation strategies, I ran two separate ANOVA's for effort (difficulty) and negative affect (negativity) that used the following structure: 2 (Context: Proactive or Reactive) x 3 (Strategy: Watch, Reappraise, Suppress) x 2 (Valence: Negative or Neutral) repeated-measures ANOVA (similar to the procedure in Herrera et al., n.d.). Context, strategy, and valence were treated as within-subjects factors. Table 6 provides average negativity scores, and Table 7 provides average difficulty scores, based on the 12 conditions of E1.

Negativity Ratings. A repeated-measures factorial ANOVA revealed that participants feelings of negativity differed significantly between the valence conditions, $F(1,73) = 237.93$, $p < .001$, $\eta^2 = .77$, such that participants felt more negative when viewing the negatively valenced images ($M = 2.54$, $SD = .741$) compared to neutral images ($M = 1.98$, $SD = .584$). This suggests that the emotion induction in the experiment was successful.

Feelings of negativity also differed between the timing conditions, $F(1,73) = 4.26$, $p = .043$, $\eta^2 = 0.06$; participants felt more negative in the reactive condition ($M = 2.33$, $SD = 0.723$) than in the proactive condition ($M = 2.27$, $SD = 0.725$). There were no other main effects, and no interactions reached significance (all ps > .05).

Difficulty Ratings. A repeated-measures factorial ANOVA revealed a significance difference in difficulty ratings across valence conditions, $F(1,73) = 120.11$, $p < .001$, $\eta^2 = 0.62$, where negative trials felt more difficult ($M = 2.16$, $SD = 0.809$) compared to neutral trials ($M =$

1.79, *SD* = 0.639). The factorial ANOVA also suggested that there was a main effect of strategy, $F(2, 146) = 51.85$, $p < .001$, $\eta^2 = 0.42$ (see Figure 7).

Follow up *t*-tests indicated that suppression (*M* = 2.06) was more difficult than look (*M* = 1.66), *t*(144.72) = -4.25, *p* = <.001, 95% CI [-.585, -.213], reappraisal (*M* = 2.26) was more difficult than look (*M* = 1.66), *t*(142.72) = -6.16, *p* = <.001, 95% CI [-.79, -.41], but reappraisal and suppression did not differ significantly, *t*(145.5) = 1.967, *p* = .051, 95% CI [-.0009, .4].

There was also a two-way interaction between valence and strategy, $F(2, 146) = 4.85$, $p = .01$, $\eta^2 = 0.06$, see Figure 8. Follow-up *t*-tests indicated that the difference in difficulty between reappraisal (*M* = 2.5) and suppression (*M* = 2.25) was significant for negative trials, *t*(145.99) = 1.12, *p* = .03, 95% CI [.158, .48], but not for neutral trials *t*(142.37) = 1.539, *p* = .126, 95% CI [-.04, .33]. The look versus suppression comparison remained significant across both valences, negative: *t*(144.72) = -4.24, *p* <.001, 95% CI [-.58, -.21], neutral: *t*(144.29) = -4.196, *p* <.001, 95% CI [-.51, -.18]. The look versus reappraisal comparison remained significant across both valences, negative: *t*(142.72) = -6.15, *p* <.001, 95% CI [-.79. -.41], neutral: *t*(136.49) = -5.42, *p* <.001, 95% CI [-.68, -.32].

Table 4

Means and Standard Deviations of Negativity Scores Across Conditions in E1

	Proactive		Reactive	
	Negative	Neutral	Negative	Neutral
Strategy				
Look	2.54(.744)	1.94(.621)	2.64(.778)	1.98(.520)
Reappraise	2.49(.723)	1.97(.575)	2.56(.721)	1.96(.611)
Suppress	2.51(.736)	1.94(.611)	2.52(.758)	2.10(.566)

Note. Standard deviations in parentheses.

Table 5

Means and Standard Deviations of Difficulty Scores Across Conditions in E1

	Proactive		Reactive	
	Negative	Neutral	Negative	Neutral
Strategy				
Look	1.79(.695)	1.49(.525)	1.79(.731)	1.51(.513)
Reappraise	2.45(.753)	2(.676)	2.51(.795)	2(6.74)
Suppress	2.28(.741)	1.79(.624)	2.2(.821)	1.93(.578)

Note. Standard deviations presented in parentheses.

Figure 5

Main Effect of Strategy on Feelings of Difficulty

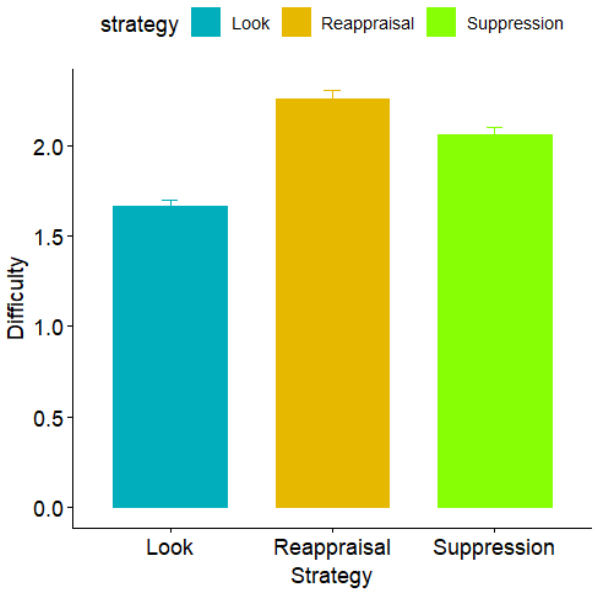
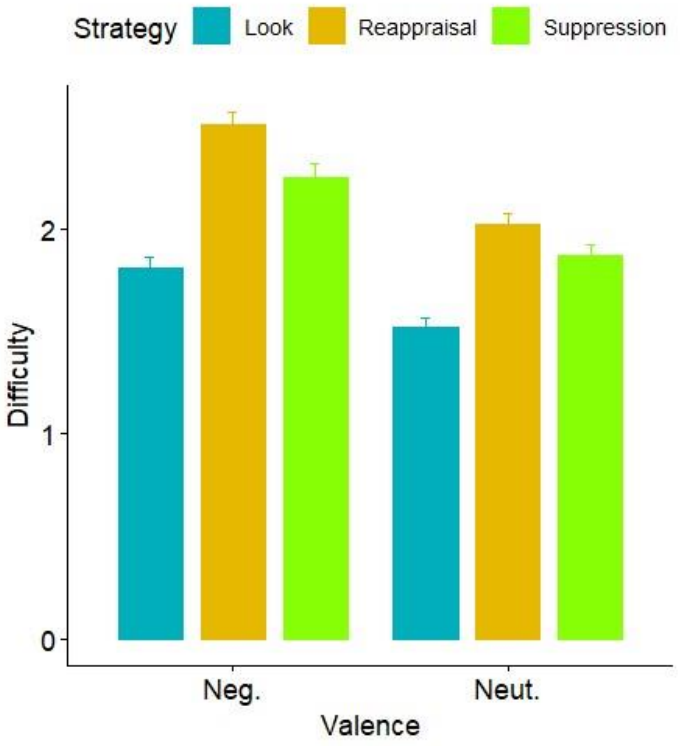


Figure 6

Strategy by Valence Interaction on Feelings of Difficulty



Note. Neg. = Negative. Neut. = Neutral

Questionnaires

To examine the correlation between participants everyday use of reappraisal and suppression with their performance during the emotion regulation task, I correlated each participants average difficulty rating for a given strategy during the task with their subscale score on the emotion regulation questionnaire (ERQ) corresponding to the same strategy. I also conducted Pearson correlations on participants subscale scores of the PANAS with feelings of negativity during the emotion regulation task. Summary statistics for all of the questionnaires are provided in Table 8 below

ERQ. ERQ scores (both first time, ERQ1, and the second time, ERQ2) on the ERQ's subscale for suppression did not correlate with participants mean difficulty ratings when using suppression in the emotion regulation task, ERQ1: $t(72) = -1.46$, $p = .147$, $r = -.17$, 95% CI [-0.38, 0.06], ERQ2: $t(71) = -1.06$, $p = .293$, $r = -.12$, 95% CI [0.34, 0.1]. Scores on the ERQ's subscale for reappraisal did not correlated with participants mean difficulty ratings when using reappraisal in the emotion regulation task, ERQ1: $t(69) = -1.67$, $p = .247$, $r = -.14$, 95% CI [-0.36, 0.09] , ERQ2: $t(71) = -1.86$, $p = .066$, $r = -.21$, 95% CI [-0.42, 0.14].

PANAS. Scores on the PANAS' subscale for feelings of positivity did not correlate with feelings of negativity (across all trials) during the emotion regulation task, $t(71) = -1.87$, $p = .066$, $r = -.21$, 95% CI [-0.43, 0.01], but the subscale for feelings of negativity did correlate marginally with feelings of negativity (across all trials) during the emotion regulation questionnaire, $t(71) = 1.98$, $r = -.23$, $p = .05$, 95% CI [-0.0009, 0.43]. Exploratorily, I also looked at how feelings of negativity during "look" trials only (when they don't regulate their emotions) correlated with the negative subscale of the PANAS. This correlation was marginally significant, $t(71) = 1.92$, $r = -.22$, $p = .058$, 95% CI [-0.007, 0.43].

Table 6

Questionnaire Data in E2

Questionnaire and Subscale		Mean (*SD*)	Min-max
ERQ1			
	Reappraisal	3.78(1.13)	0-6
	Suppression	2.99(1.32)	0-6
PANAS			
	Positive	25.27(5.97)	13-41
	Negative	17.78(5.03)	10-34
TLX			
	Mental	50.94(25.33)	3-100
	Physical	10.19(19.15)	0-100
	Hurry	30.49(22.69)	0-90
	Success	82.73(18.42)	28-100
	Difficulty	46.10(28.25)	0-100
	Frustrated	31.53(28.25)	0-97
	Motivated	76.26(21.934)	7-100
ACS		46.15(6.65)	33-62
ACDS			
	Distraction	1.76(0.74)	0-3
	Shifting	1.35(0.74)	0-3
ERQ2			
	Reappraisal	3.77(1.33)	0-6
	Suppression	3.02(1.48)	0-6

Note. ERQ1 = Emotion Regulation Questionnaire (first time). PANAS = Positive and Negative Affective Schedule. TLX = Task Load Index. ACS = Attentional Control Scale. ACDS = Attentional Control- Distraction and Shifting Scale. ERQ2 = Emotion Regulation Questionnaire (second time).

Discussion

Experiment 1 examined the effectiveness of reappraisal and suppression on feelings of difficulty and negativity. In this experiment, participants either had time to prepare (proactive) to regulate their emotions using a pre-specified strategy or did not have time to prepare (reactive) to regulate their emotions with the pre-specified strategy. As is standard in many emotion regulation experiments, participants completed both negative (emotional) and neutral

(nonemotional) trials, to help determine whether the emotion induction was successful. At the end of each trial, participants rated how negative they felt, and how difficult the trial was.

The first notable finding was the effect of valence on feelings of negativity. Participants rated their feelings of negativity as higher for negative trials compared to neutral trials, and the magnitude of this effect (based on Cohen's [1988] standards) was quite large ($\eta^2 = .77$). This provides support for the assumption that participants did in fact experience a negative emotion to the negatively valenced images compare to the neutral images.

The next significant result was the effect of timing on feelings of negativity. Participants rated their feelings of negative as higher on the reactive trials compared to proactive trials, and the magnitude of this effect was medium ($\eta^2 = .06$). This provides support for my hypothesis that, overall, proactively implementing emotion regulation is more effective than reactively implementing it. However, there was no main effect of strategy on negativity, meaning that participants feelings of negativity did not differ between trials where they used reappraisal versus suppression versus just looking at the image. Discussion of this failure to replicate a basic emotion regulation effect is discussed further in the General Discussion section.

Regarding participants ratings of difficulty, there was a main effect of valence, where participants rated negative trials as more difficult than neutral trials, and this effect was large in magnitude ($\eta^2 = .62$). I also observed a main effect of large magnitude ($\eta^2 = .42$) of strategy on feelings of difficulty, where reappraisal was the most difficult, followed by suppression, and lastly by look. This is puzzling; participants felt that reappraisal and suppression were more difficult than just looking at the images, but the strategies made no difference in how negative participants felt after using them to regulate their emotions.

Contrary to my hypothesis, there was no interaction between strategy and timing, for both feelings of negativity and feelings of difficulty. This suggests that the difference in the effectiveness of specific emotion regulation strategies, in my study, did not differ between proactive and reactive conditions. However, I am hesitant to conclude this given that, as mentioned previously, the emotion regulation strategies participants were told to use seemed to make no difference at all on feelings of negativity.

One potential reason for this is that participant may not have always complied with task instructions. On each trial, participants did not have to report which strategy they actually used, and so I can't say for certain that they did in fact make use of reappraisal or suppression when instructed to, nor if they just looked at the images when instructed to. This limitation is addressed in my second experiment, where at the end of each trial participants had to indicate which strategy they used to regulate their emotions.

Another aim of E1 was to correlate trait use of suppression and reappraisal as emotion regulation strategies with performance during the emotion regulation task. To my surprise, there were no correlations between everyday use of the strategies and their effectiveness in the task. I also correlated participants current mood with their feelings of negativity during the study, which did not reach significance.

Experiment 2

Experiment 2 (E2) aimed at replicating the results of Experiment 1 (E1) and extending the design to include trials where participants were able to choose which strategy they wanted to use to regulate their emotions. On each trial, participants rated how negative they felt, how difficult the trial felt, and which strategy they used. This improved design allowed me to address

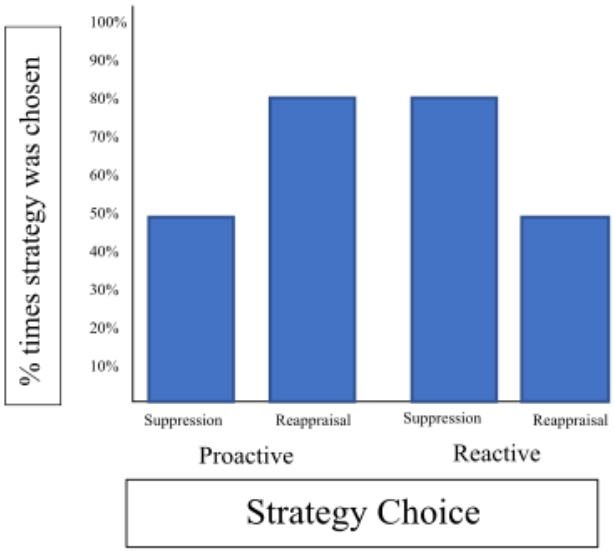
the limitation of not knowing compliancy in E1. By including free choice trials, I was also able to examine which strategies participants choose when they are prepared ahead of time to do so (proactively) and when they have no time to prepare (reactively). Looking at which strategies participants choose provides evidence of the ways that people may regulate their emotions in a more externally valid way, since in an everyday scenario an individual is free to regulate however they see fit. Lastly, the free choice trials may provide insight about how much effort participants were willing to use during the experiment, based on which strategy they choose since some strategies are thought to be high effort compared to others.

Hypotheses

E2 had all of the same hypotheses as in E1, except for the following: I hypothesized that when participants are cued proactively about having to choose between strategies, reappraisal would be chosen more often, and when they were cued reactively, suppression would be chosen more often (Figure 9). This hypothesis is based on the finding that, when given the choice between an earlier versus later occurring strategy, participants consistently choose the earlier strategy in low emotional intensity situations, and choose the later strategy in the higher emotional intensity situations (Sheppes et al., 2011). While the study that I am citing here compares distraction to reappraisal, I am proposing that these findings will generalize to suppression and reappraisal. Because reappraisal occurs earlier than suppression does, it is more likely to be chosen in the proactive condition (low emotional intensity because the emotion has not fully generated) and suppression is more likely to be chosen in the reactive condition (high emotional intensity because the emotion has fully generated) since it occurs later in the generation of an emotion.

Figure 7

Additional Predicted Results of E2



Method

All of the same methods from E1 were used in E2, with a few exceptions outlined below.

Sample and Sample Size Justification

To account for the addition of "choice" trials in E2, I conducted a power analysis again in R Studio using the Superpower package, with slight modifications. The additional power analysis was a 4 (Strategy: Suppress, Reappraise, Watch, Choose) x 2 (Context: Proactive, Reactive) within-subjects design, with the outcome variable being proportion of time a strategy was chosen. Means, standard deviations, and correlations were chosen based on previous research looking at the effect of intensity on emotion regulation choice (Hay et al., 2015; Shafir et al., 2015). Unfortunately, most studies either do not test or do not report the percentage of times participants choose to "look" at an image, and so this value was estimated to be 20% given that looking at an image tends to result in worse feelings compared to regulating (and therefore

should be chosen at a lower percentage). With the power analysis of the 4 x 2 design, I determined at least $n = 50$ participants were needed to have 89.7% power to detect a small effect size ($f = 0.10$), and at least $n = 30$ participants were needed to have 98.8% power to detect a medium effect size ($f = 0.23$). Based on these power analyses, I planned to recruit $n = 100$ participants again to ensure that even after data cleaning and deletion, I had sufficient power to conduct my statistical analyses

Emotion Regulation Task

Emotion Inducing Images. One hundred stimuli lists were produced using the same algorithm and package as mentioned in E1 (LexOPS), but instead of producing 60 pairs of images, it produced 64 pairs to account for the addition of choice trials in E2. Again, the NAPS (Marchewka et al., 2014) was used for the image database. This resulted in a total of 128 images per image list, 64 for each of the two blocks, further broken down into 8 negative and 8 neutral for each condition (see Table 9 for conditions). Out of the 1356 images available in the NAPS database, 547 unique images were used across the stimuli lists.

Experimental Design

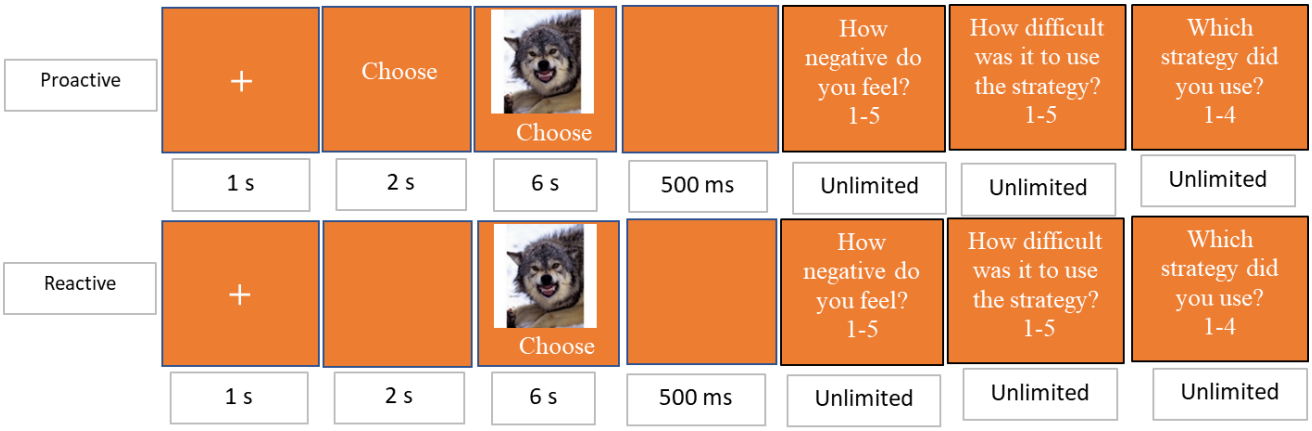
Task Design. E2's emotion regulation task was identical to E1 (including having both proactive and reactive cues) with the exception of additional "Choose" trials where participants were free to choose what strategy they want to implement and were asked to indicate which strategy they used on all trials (including the trials where they don't choose). The following options were provided: 1 = *Reappraisal*, 2 = *Suppression*, 3 = *Other*, 4 = *None*. See the additional Choose trial structure in Figure 6 below. Participants completed the trials over two blocks (64 trials each) separated by a 5 min break, with 8 trials per condition for all conditions,

resulting in a total of 128 trials. Therefore, the experiments design was within-subjects and fully crossed/balanced. Each block took ~13 min each. Prior to starting the first task block, participants had to complete one practice trial for each condition (16 trials), which took ~3 min.

Task Instructions. As in E1, E2 will require participants to read the instructions provided on screen which tells them what to do when they see the three cues, with the addition of an explanation of what to do when they are prompted by the cue "Choose" (see Appendix B for full instructions).

Figure 8

Additional Trial Type in E2



Note. For the last question of each trial ("What strategy did you use"), participants may indicate: 1 = Reappraisal, 2 = Suppression, 3 = Other, 4 = None.

Table 7

Conditions in E2

	Suppress	Reappraise	Watch	Choose
Proactive	Negative Neutral	Negative Neutral	Negative Neutral	Negative Neutral
Reactive	Negative Neutral	Negative Neutral	Negative Neutral	Negative Neutral

Note. Each trial was done 8 times in pseudorandomized order.

Procedure

E2's procedure is identical to E1, with the exception that participants only did the ERQ once in E2.

Results

As in E1, E2 was preregistered on the Open Science Framework (https://osf.io/v6rw9), and all materials were posted to follow open science research practices (https://osf.io/gzhve/).

Participant Characteristics and Data Screening

Participants were recruited starting on January 29, 2024, and data collected until June 28, 2024 were included for analysis. There were 44 sign-ups for my second experiment (E2); out of those who signed up, 36 attended and were granted credit for participating. All participants consented and only one participant withdrew from the study. Summarized demographics of the participants are provided in Table 10 below. Using the data cleaning procedures from E1, six participants were filtered out from data analysis, leaving 30 usable participant files.

Table 8

Demographics of Participants in E2

Characteristic	Mean *(SD)*	*N* (%)
Age	22.33(6.8)	
Gender		
Female		20(66.7)
Male		10(33.3)
Ethnicity		
Black		9(30)
Indigenous		2(6.7)
White		14(46.7)

Note. Not all ethnicities reported are included in this table.

Emotion Regulation Task

In E2, my analysis of difficulty and negativity was similar as in E1. I ran two repeated-measures ANOVA for each of difficulty and negativity with the following structure: 2 (Context: Proactive or Reactive) x 3 (Strategy: Look, Reappraise, Suppress, Choose) x 2 (Valence: Negative or Neutral). The dependent variables were feelings of negativity and feelings of difficulty. For the choice data, the original plan of running a multinomial logistic regression was too complicated for the time constraints and scope of my thesis, and so instead I decided to run an ANOVA using the following structure: 2 (Timing: Proactive or Reactive) x 2 (Valence: Negative or Neutral) x 3 (Response: Reappraise, Suppress, Look). The dependent variable was the proportion of times a specific response was chosen in each of the conditions, calculated as:

$$Proportion = \frac{\sum(\#of \text{ reappraise responses } in\ condition\ 1)}{\sum(\#all\ responses\ in\ condition\ 1)}$$

If a participant never chose one of the options in one or more specific condition, its value was filled in as zero. Because I ran the ANOVA on a proportion variable, I had to take out one of the four choice options, because the proportions would have summed to 1, and therefore an ANOVA

would be inappropriate. I have chosen to exclude trials where participants chose "Other" (option 4) because it is not pertinent to my hypotheses and is likely less informative given that we don't know what "Other" is referring to. Keeping "Look" trials will tell us when participants chose to simply attend to the image versus when they chose to actively regulate how they felt (using suppression or reappraisal).

Negativity Ratings. A repeated-measures factorial ANOVA indicated that feelings of negativity differed between the two valences, $F(1, 28) = 159.52$, $p < .001$, $\eta^2 = .85$, such that participants felt more negative when viewing the negative images ($M = 2.37$, $SD = 0.697$) compared to viewing the neutral images ($M = 1.91$, $SD = 0.651$). No other main effects or interactions were significant (p's >.05).

Difficulty Ratings. A repeated-measures factorial ANOVA indicated a significant difference in difficulty across valence conditions, $F(1,28) = 59.01$, $p < .001$, $n^2 = 0.68$, such that participants felt it was more difficult during negative trials ($M = 1.87$, $SD = 0.712$) compared to neutral trials ($M = 1.58$, $SD = 0.573$). This ANOVA also suggested that participants felt that trials were more difficult based on the different strategies they were instructed to use, $F(3, 84) = 6.23$, $p = .002$, $n^2 = 0.1$. Follow up t-tests suggest that reappraisal ($M = 2.12$) was more difficult than suppression ($M = 1.77$), $t(57.43) = 2.095$, $p = .041$, 95%CI [.015, .68], but that no other strategies differed in their difficulty ratings (all p's > .05).

Response Choice. A repeated-measures factorial ANOVA[1] suggested that there was a main effect of response on choice proportion, $F(2, 56) = 21.42$, $p < .001$, $\eta^2 = .43$. Follow-up t-

[1] For the choice data, my original data analysis plan was to use a multinomial logistic regression to look at the effect of my independent variables on likelihood of a given choice. However, for the scope of this thesis, I decided to use a simpler analysis because (1) it is easier to interpret and may have more meaningful results, and (2) multinomial logistic regression models are complex and would be beyond the expectations of a master's thesis analysis.

tests indicated that participants more often chose look compared to suppress, $t(28) = 4.402$, $p < .001$, 95% CI [.14, .38], mean difference = 0.262, and more often chose look compared to reappraise, $t(28) = 5.6176$, $p < .001$, 95% CI [0.1842, 0.3956] mean difference = 0.289, but that there was no difference in proportion of choices between suppression and reappraisal, $t(28) = -0.91$, $p = 0.371$, 95% CI [-0.0918, 0.35] mean difference = -0.262. This suggests that the strategy look was chosen on average 26.2% more times than to suppress, and on average 28.9% more than to reappraise (see Figure 8 below).

The ANOVA for choice also suggested that there was an interaction between valence and response, $F(2, 56) = 5.42$, $p = .013$, $\eta^2 = .16$. Follow-up *t*-tests indicated that the main effect of response depended on valence, where reappraisal was more often chosen in the negative compared to neutral trials, $t(28) = 4.1065$, $p < .001$, 95% CI [0.0309, 0.0925], mean difference = 0.0617, and look was more often chosen in the neutral condition than in the negative condition, $t(28) = -2.2985$, $p = .029$, 95% CI = [0.1225, -0.007] mean difference = -0.0648. See Figure 9 below for visualization. No other main effects or interactions reached significance.

Table 9

Means and Standard Deviations of Negativity Scores Across Conditions in E2

	Proactive		Reactive	
	Negative	Neutral	Negative	Neutral
Strategy				
Look	2.469(0.68)	2.084(0.726)	2.3305(0.881)	1.893(0.599)
Reappraise	2.423(0.657)	1.863(0.72)	2.414(0.769)	1.960(0.59)
Suppress	2.377(0.615)	1.850(0.592)	2.737(0.714)	1.899(0.752)
Choose	2.41(0.79)	1.937(0.667)	2.343(0.50)	2.01(0.604)

Note. Standard deviations presented in parentheses.

Table 10

Means and Standard Deviations of Difficulty Scores Across Conditions in E2

	Proactive		Reactive	
	Negative	Neutral	Negative	Neutral
Strategy				
Look	1.856(0.711)	1.61(0.697)	1.707(0.808)	1.484(0.568)
Reappraise	2.15(0.67)	1.778(0.717)	2.08(0.78)	1.687(0.49)
Suppress	1.741(0.613)	1.503(0.439)	1.798(0.69)	1.53(0.529)
Choose	1.84(0.611)	1.626(0.56)	1.839(0.611)	1.626(0.56)

Note. Standard deviations presented in parentheses.

Figure 9

Main Effect of Response on Choice Proportion

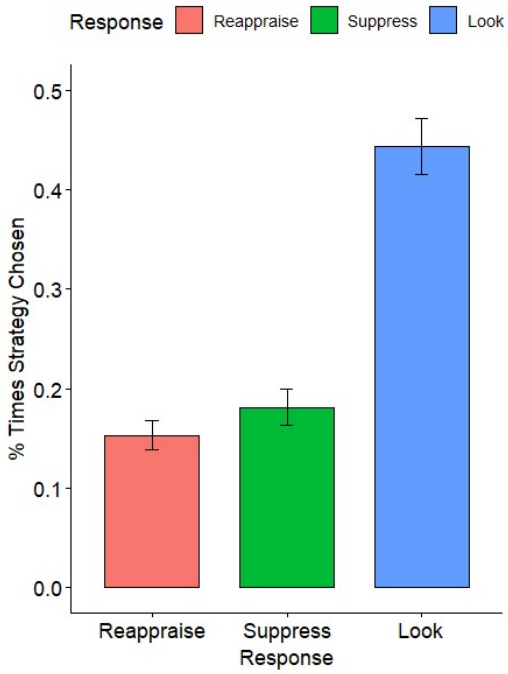


Figure 10

Response by Valence Interaction on Choice Proportion

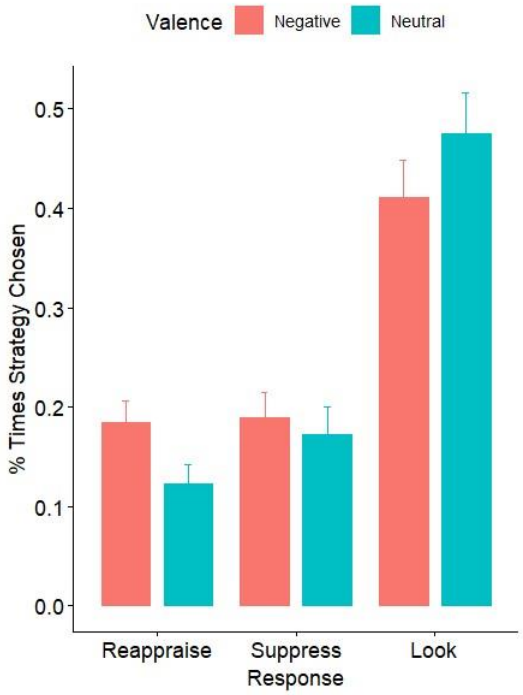


Table 11

Questionnaire Data in E2

Questionnaire and Subscale		Mean (*SD*)	Min-max
ERQ1			
	Reappraisal	4.13(0.92)	1.5-5.5
	Suppression	2.73(1.29)	0.75-6
PANAS			
	Positive	27.2(5.95)	12-38
	Negative	18.4(4.3)	11-34
TLX			
	Mental	50.63(27.85)	0-100
	Physical	16.6(26.42)	0-100
	Hurry	31.06(20.64)	0-76
	Success	85.7(13.37)	56-100
	Difficulty	51.2(25.79)	2-100
	Frustrated	38.26(33.66)	0-100
	Motivated	79.76(22.21)	0-100
ACS		45.06(6.56)	33-56
ACDS			
	Distraction	1.85(0.71)	0-3
	Shifting	1.41(0.78)	0-3

Note. ERQ1 = Emotion Regulation Questionnaire (first time). PANAS = Positive and Negative Affective Schedule. TLX = Task Load Index. ACS = Attentional Control Scale. ACDS = Attentional Control- Distraction and Shifting Scale. ERQ2 = Emotion Regulation Questionnaire (second time).

Questionnaires

The analyses used in E1 to examine correlations between the questionnaire scores and task performance were use in E2. Descriptive statistics of all questionnaires from E2 are presented in Table 13 below.

ERQ. Scores on the ERQ's subscale for suppression did not correlate with participants mean difficulty ratings when using suppression in the emotion regulation task, $t(28) = -.11$, $p = .911$, $r = -.02$, 95% CI [-0.38, 0.34], . Scores on the ERQ's subscale for reappraisal did not correlated with participants mean difficulty ratings when using reappraisal in the emotion regulation task, $t(26) = -.73$, $p = .471$, $r = .14$, 95% CI [-0.38, 0.34].

PANAS. Scores on the PANAS' subscale for feelings of positivity did not correlate with feelings of negativity (across all trials) during the emotion regulation task, $t(28) = -1.16$, $p = .255$, $r = .214$, *95*% CI [-0.15, 0.53], nor did scores on the PANAS' subscale for feelings of negativity correlate with feelings of negativity (across all trials) during the emotion regulation task , $t(28) = -.0.17$, $p = .867$, $r = -.031$, 95% CI [-0.38, 0.33]. Exploratorily, I also looked at how feelings of negativity during "look" trials only (when they don't regulate their emotions) correlated with the negative subscale of the PANAS. This correlation was nonsignificant, $t(28) = -.35$, $p = .728$, $r = -.66$, 95% CI [-0.41, 0.3].

Exploratory Analyses

Exploratorily, I decided to analyze the extent to which participants followed through with the strategy they were instructed to use. Here, compliance is calculated as whether a participant used the same strategy to regulate their emotions as they were instructed to (i.e., when they were instructed to use reappraisal, did they respond "reappraisal" when asked which strategy they used). Table 14 below provides averages of participants compliance in the different conditions of the experiment. However, note that the averages do not provide a full picture of compliance. In this sample, compliance ranged from 0% - 100% for certain strategy types. Some participants never complied with the strategy instruction in certain conditions. To analyze compliance data, I ran a repeated-measures factorial ANOVA (see Table 18 below), with the following structure: 2

(valence: negative and neutral) x 3 (strategy: reappraise, look, suppress) x 2 (timing: proactive and reactive).

Based on the factorial ANOVA, the only predictor that reached statistical significance was the valence by strategy interaction, $F(2, 58) = 4.73$, $p = .018$, $\eta^2 = .14$, 95% CI [.02, .27]. Follow-up *t*-tests suggested that compliance was greater for reappraisal in the negative condition ($M = 84\%$) compared to reappraisal in the neutral condition ($M = 79.5\%$), $t(29) = 2.06$, $p = .048$, 95% CI [.0004, .089], mean difference = .044, although only marginally so given how close the *p* value is to .05 and that the lower bound 95% CI is near zero. There was no difference in compliance between the two valences for suppression, $t(29) = -0.47$, $p = .64$, 95% CI [- .04, .025], or for look , $t(29) = -1.67$, $p = .104$, 95% CI [-.10, .10].

Table 12

Means and Standard Deviations for Proportion Compliance Data

	Proactive		Reactive	
	Negative	Neutral	Negative	Neutral
Strategy				
Look	82(.38)	.88(.32)	.83(.37)	.86(.34)
Reappraise	.83(.37)	.80(.40)	.84(.36)	.79(.40)
Suppress	.83(.37)	.85(35)	.80(.40)	.80(.39)

Note. Standard deviations presented in parentheses. "Choose" trials do not appear here given that there is nothing to comply to for choice trials. Values represent the percentage of times that participants complied with the instructions.

Discussion

Experiment 2 was designed as a conceptual replication of Experiment 1 and aimed to explore how participants choose to regulate their emotions when given the option to select from multiple strategies. Participants completed an emotion regulation task where they viewed

emotional and nonemotional images and had to use specific strategies to regulate their emotions, as well as freely choose among multiple strategies to regulate their emotions. On each trial, participants had to indicate which strategy they used to regulate their emotions, even on forced choice trials where they were instructed to use a specific one. This allowed for an examination of compliancy during the task. They also indicated on each trial how negative they felt and how difficult it felt.

In terms of the forced choice trials, I observed a main effect of valence on negativity, where participants felt more negative on trials with negative images and less negative on trials with neutral images, suggesting that the emotion induction was successful (with a large effect size, $\eta^2 = .85$). There were no differences in negativity ratings across the proactive and reactive timing conditions within the forced choice trials. This result differed from Experiment 1, where participants felt more negative during reactive trials compared to proactive trials. Lastly, there was no main effect of strategy on feelings of negativity, replicating this result from Experiment 1, again suggesting that the strategies made no difference on participants negativity.

For difficulty, I observed a main effect of valence, whereby negative trials were more difficult than neutral ones. This replicates the same effect observed in Experiment 1. I also observed a main effect of strategy, whereby participants felt that reappraisal was more difficult than suppression, but no difference between look and reappraisal and look versus suppression. This result differed from Experiment 1, where I found that reappraisal was more difficult than look, suppression was more difficult than look, but that reappraisal and suppression were not different in difficulty.

Regarding free choice trials, I observed a main effect of response on choice proportions, where participants chose “look” to a greater extent than they chose “reappraise” and to a greater

extent than they chose “suppress”. This suggests that participants favoured looking at images rather than trying to regulate their emotions using suppression or reappraisal. There was however an interaction between valence and response on choice proportion. Participants chose “reappraise” more in negative versus neutral trials, chose “look” more in neutral trials versus negative trials, but chose “suppress” to the same extent in both negative and neutral trials. This suggests that while overall participants chose to look more frequently than to suppress or reappraise, when participants had to regulate a negative image, they would choose reappraisal more than when they had to regulate a neutral image. It also suggests that when they had to regulate a neutral image, they would choose “look” more than when they had to regulate a negative image. Intuitively, this makes sense since one would think there is some degree of motivation to try to change how you feel when feeling a negative emotion compared to not feeling any emotion.

E2 had an additional design feature from E1, such that on every trial, regardless of if it was a free choice or forced choice trial, participants were asked to indicate which strategy they used. This allowed for an estimation of participants compliance with the instruction cues. In forced choice trials, there was a wide range in compliance. For some participants, under certain conditions, compliance was as low as 0% or as high as 100%. The analysis of this data however only yielded a significant two-way interaction between valence and strategy, such that compliance for reappraisal trials was higher when the image was negative compared to when the image was neutral, but neither suppression nor look trials differed between the negative versus neutral images.

General Discussion

In two experiments, I investigated the effectiveness of emotion regulation through the dual mechanisms of cognitive control lens to try to understand if emotion regulation efficacy is different when people have time to prepare (proactive) compared to when they do not have time to prepare (reactive). Participants completed an emotion regulation task where they had to make use of emotion regulation strategies to try and change how they felt in response to negative and neutral images. Participants were either cued proactively (before the image) or reactively (at the same time as the image) about the strategy they had to use or if they were to simply look at the image. Participants then rated how negative they felt and how difficult it felt to use the strategy during the trial. Experiment 2 additionally involved free choice trials where participants were free to choose among multiple regulation strategies to try and change how they felt. Participants in this experiment further had to report on every trial what strategy they used.

In Experiment 1, participants felt more negative during the negative trials than the neutral trials and felt more negative during the proactive trials compared to the reactive trials. There was no main effect of strategy on negativity, suggesting that the strategies made no impact on how negative participants felt. In Experiment 2, I replicated the effect of valence on negativity (participants felt more negative for the negative images than the neutral images), but did not observe a difference in feelings of negativity between the proactive and reactive conditions, contrary to my first experiment. Furthermore, both experiments showed that the strategies made no impact on feelings of negativity.

For difficulty, participants felt that the negative trials were more difficult than the neutral trials in both experiments. However, Experiment 2 did not fully replicate the main effect of strategy on difficulty ratings. In Experiment 1, reappraisal trials were rated as the most difficult, followed by suppression, followed by look trials. In Experiment 2, only reappraisal and

suppression were different in terms of difficulty, where reappraisal was rated as more difficult than suppression. Across both experiments, there was no main effect of proactive versus reactive strategy usage on difficulty ratings, suggesting that proactively regulating emotions and reactively regulating emotions are approximately equal in how difficult they feel.

Regarding the free choice trials in Experiment 2, I found that participants chose to simply look at the images more than they chose to use either reappraisal or suppression. There was a two-way interaction where choosing reappraisal was more common for negative trials compared to neutral trials, and choosing look was more common in neutral trials compared to negative trials. There were no other significant effects on proportion of choices.

In Experiment 2, as an exploratory analysis, I also looked at participant compliance. Here, there was only a significant interaction effect of strategy in valence, such that participants were more compliant for the instruction to reappraise when the image was negative compared to when the image was neutral. No other main effects or interactions were observed. Descriptively, participant compliance was around 80% across all condition types and across all participants, but there was notable variation in this as some compliance scores were as low as 0% or as high as 100%.

There are four general observations from my studies that I would like to discuss in greater detail, which are (1) the effect of timing on efficacy (timing influenced negativity but not difficulty), (2) my experiments did not replicate the main effect of strategy on feelings of negativity commonly seen in most emotion regulation studies, (3) strategy influenced difficulty but not negativity, and (4) emotion regulation choice does not depend on timing. After I discuss these, I review the strengths and limitations of my studies, and lastly future directions.

Inconsistent Effects of Proactive Versus Reactive Timing on Efficacy

In Experiment 1, I observed that proactive regulation was more effective at changing emotion experiences than reactive regulation. In Experiment 2, I did not observe a difference in efficacy based on the proactive and reactive conditions. The result of Experiment 1 confers theoretically with Gross' (1998b) assertion that emotion regulation occurring early in the generation of an emotion, before it is fully activated, is more effective than doing so after the emotion is generated (also called the generic timing hypothesis; Sheppes & Gross, 2011). Wang et al. (2024) found similar evidence and observed a greater reduction in feelings of negativity in proactive trials compared to reactive trials. However, one study using this proactive and reactive emotion regulation paradigm did not find the same. Wang et al. (2022) compared emotional experience ratings between one group that used emotion regulation proactively and the other group which used emotion regulation reactively. They found no significant difference in emotional experiences based on group, suggesting that the amount of time participants were given to prepare to use a strategy was not impactful on how effective that strategy was. In contrast to the effect of proactive and reactive strategy usage on feelings of negativity, I did not observe a difference between proactive and reactive strategy usage in terms of difficulty ratings. This opposes Wang et al. (2024) who did find a difference in difficulty based on proactive and reactive strategy use. The reactive group in their study had greater late positive potentials (proxy of cognitive effort) compared to the proactive group, suggesting that the reactive condition was more difficult than the proactive condition.

What could account for this heterogeneity in the effect of proactive versus reactive emotion regulation on efficacy? One potential explanation is that the Wang et al. (2022) used a between subjects design where participants only did either proactive or reactive trials and not

both, whereas Wang et al. (2024) used a within-participants design where participants did both proactive and reactive trials. The proactive and reactive emotion regulation task design loosely reflects the AX-CPT task (Braver et al., 2008), which requires that participants complete both proactive and reactive trial types. Therefore, perhaps the effect of proactive versus reactive emotion regulation can only be observed when participants complete both types of trials. Beyond the emotion regulation studies using trial design similar to that of the AX-CPT task, there is further disagreement regarding the influence of timing on emotion regulation efficacy.

My study provides partial support for the generic timing hypothesis, in the form of a main effect of timing on negativity (in E1) but contradicts it in the form of no main effect of timing on difficulty (in E1 or E2). Further, it does not provide support for the process-specific timing hypothesis, given that there was no difference in the effectiveness (both negativity and difficulty) based on strategy and timing (of particular note is reappraisal, because the process specific hypothesis asserts it would be better when used proactively than reactively). However, as I discuss next, I am hesitant to conclude that the generic timing hypothesis is unfit for understanding emotion regulation efficacy, because my study failed to find an effect of strategy on feelings of negativity at all.

No Main Effect of Strategy on Negativity

Across both studies, the emotion regulation strategies made no difference in how negative participants felt (no main effect of strategy on negativity). On average, participants felt the same level of negativity when they just looked at the images compared to when they reappraised their meaning or when they suppressed their reaction to the images. This is a failure to replicate a basic and robust finding in the emotion regulation literature that using these strategies can change the experience of emotion (for a review see Webb et al., 2012). I have

several ideas that could help explain why the strategies made no difference on feelings of negativity, which I briefly discuss below.

Inconsistent Emotion Induction. Across both experiments, it appeared that the emotion induction was successful since participants felt more negative for negative images compared to neutral images. But, as argued by Pascual-Leone et al. (2016) the emotional images used in the majority of experiments on emotion, are really only a proxy to an individuals experience of an emotion. The assumption made by these kinds of experiments (including mine) is that the negative images do in fact evoke some form of negative emotion, and that since they are experimentally controlled, this experience or response is the same across individuals within a study. Realistically, there is no way to confirm that the experience of emotion is consistent between participants, or even across the trials of a single participant. Based on this argument, it may be possible that in my study, between participants or across trials, there were differences in the degree to which they had an emotional experience or response, which in turn would influence the degree to which regulating that experience actually changed it. If there is little or no emotion to regulate in the first place, trying to regulate it might not change it to the degree that it is noticeable.

Issues with Task Compliance. Another possible explanation for the null effect of strategy on negativity is that while participants were cued to use specific strategies, there is limited ability to determine whether they followed through with those instructions. In E1, participants did not report which strategy they used after the fact, if any at all, and so there is a chance that they weren't always implementing the strategy they were cued to. In E2, I addressed this limitation by having participants report at the end of every trial which strategy they used. As mentioned prior, based on the averages of each condition, it appeared that there was about 80%

compliance (meaning participants used the strategy they were instructed to most of the time) across the forced choice trials. However, there was a fair amount of variance in the degree to which participants complied, for example when looking at an individual participants compliance score, some complied as little as 0% of the time for one or more strategy types. Further, if I considered Herrera et al.'s (2024) definition of compliance (the degree that participants chose to use a regulation strategy compared to just looking at the images) then the participants in my study would have fairly low compliance. Therefore, I could also take the fact that participants chose to just look at the images 40% of the time as a proxy of task compliancy beyond participants confirming or disconfirming that they followed the instructions in forced-choice trials. This supports my suggestion that one reason I was unable to replicate the effect of strategy on negativity is because participants were not complying with or because they were not legitimately engaging with the strategies and task.

While E2 did provide some insight into how well participants were complying, this measurement rested on the assumption that participants were both honest and accurate when reporting which strategies they used. Other studies have measured similar constructs, such as "adherence" to instructions. Schnabel et al. (2022) reported participants subjective estimates of how well they were able to adhere with the strategy instruction as about 69%. This suggests that it is possible participants try their best to comply with instructions, but sometimes have a hard time truly implementing the strategy.

Measurement Bias. When looking at emotion regulation studies that use a dependent variable other than subjective experiences, the effect of the different strategies on emotion are less consistent. For example, MacNamara et al. (2022) reviewed emotion regulation studies where event-related potentials (ERPs) served as the dependent variable to estimate participants

emotion experiences. They list 14 articles that were unable to find any effect of reappraisal on emotion experiences. Therefore, I speculate that subjective ratings of emotion experiences may be predisposed to demand characteristics, and that objective measurements like ERPs are less susceptible to this. Like many other emotion regulation studies, the current research used a subjective measure of emotion regulation efficacy, which may be susceptible to demand characteristics. Participants were given plenty of instruction and examples about what the strategies are and how they "should" work in a given context. For example, I adapted instructions from Herrera et al. (2024) and explained how to use reappraisal in the following way: "When you see the instruction to reappraise we want you to think of something to tell yourself that helps you to feel less negative about the picture". This is a standard way that emotion regulation instructions are described, which explicitly states how participants should feel by the end of the trial. Arguably, this may be encouraging participants to respond in a certain way, thereby influencing participants' ratings of how negative they feel, and subsequently influencing how many studies find an effect of these strategies on feelings of negativity.

Insufficient Regulation. Lastly, the trial design of my experiments may have influenced the ability of the strategies to impact feelings of negativity. For example, participants had a total of 6.5 s to attempt to regulate their emotions before they were asked how negative they felt. It is not unreasonable to imagine that this may not have been enough time for some participants to make use of the strategies. My trial design is based on past research (Wang et al., 2022) that looked at the effect of timing on emotion regulation and gave participants 5.5 seconds to use the strategies. They found that compared to the look trials, participants felt less negative during the reappraisal trials, suggesting that there was enough time for the strategies to be used. However, this proactive and reactive paradigm is fairly new, and has not yet, to my knowledge, been tested

by other researchers. Perhaps this trial design is too difficult to reliably see a main effect of strategy on feelings of negativity.

Taken together, there are several factors that could have influenced whether or not the emotion regulation strategies influenced feelings of negativity, including the degree of emotion induction, whether or not participants complied with the instructions, what dependent variable is used, and lastly task design. In contradiction to this null effect of strategy on feelings of negativity, participants did find the strategies to be different in terms of difficulty, presenting a paradoxical finding.

Main Effect of Strategy on Difficulty but not Negativity

In both experiments, there was a main effect of strategy on feelings of difficulty, whereby participants felt that reappraisal was the most difficult, followed by suppression, and lastly by look. Schnabel et al. (2022) compared subjective effort in reappraisal versus suppression and found that reappraisal was rated as the most difficult (or requiring the most effort), followed by suppression, and lastly by look. Taken together, both of my experiments and Schnabel et al.'s study provide further support of the idea that reappraisal feels more difficult than suppression. Subsequently, most studies then also find that participants have a significant change in feelings of negativity for trials where they had to regulate compared to trials where they only had to look at the images. However, this was not the case in my research. I have several ideas why this may have happened, which I discuss next.

Effort is Aversive. Something that could potentially account for this odd finding is the idea that subjective mental effort/difficulty is inherently negative or aversive. This idea developed as a result of studies involving testing how individuals choose to act in scenarios with

equal rewards but differing demands (e.g., Blough, 1966). The typical outcome is that participants choose the less demanding option, suggesting that people avoid effort, and is the so called “law of least effort” (Hull 1943). Kool et al. (2010) provided evidence for the application of this law of least effort to mental effort. Participants in Kool et al.’s study consistently chose the action that was associated with less effort. Generalizing this finding to my study, perhaps the emotion regulation strategies participants were instructed to use inadvertently caused them to feel negative because they required substantial cognitive effort to be expended. In turn, this may have cancelled out any effect that the strategies had on feelings of negativity that arose from viewing the negative images.

Additionally, it is possible that participants avoided using the emotion regulation strategies because they were more effortful than just looking at the images. The results of my free choice trial data suggested that, compared to using reappraisal, participants chose to simply look at the images for about 28.9% more of the trials, and compared to using suppression, participants chose to simply look at the images for about 26.2% more of the trials. However, in Experiment 2 participants did not rate suppression or reappraisal as more difficult than looking at the images, and so there is no evidence that participants chose to look at image more because the regulation strategies felt more difficult.

The next determinant they propose is cognitive complexity, for example they found that when they provided participants with concrete ways to use reappraisal, they were more likely to use it, suggesting that more complex strategies may be chosen less often specifically because they are too complex

Greater Effort Doesn’t Always Equate to Better Performance. Another potential related idea that might explain this paradoxical finding is that the relationship between cognitive

effort and performance is not universally positive (Christie & Schrater, 2015; as cited in Székely & Michael, 2021).Christie and Schrater (2015), in the context of tasks requiring judgment decisions, argue that sometimes investing more cognitive effort into a task is suboptimal and may even harm performance. To generalize this idea to emotion regulation, perhaps emotion regulation in some contexts is inherently less effective when more effort is exerted to use them. For example, the emotion regulation strategy called "acceptance" involves passively acknowledging and accepting ones thoughts and feelings without judgement, and has been argued to be more effective than effortful emotion regulation strategies (Dunn et al., 2009),. Therefore, while participants in my study reported greater difficulty for reappraisal and suppression compared to look, it is possible that this increased effort made no difference in how well the strategies worked.

In summary, it is odd that participants rated the strategies as different in terms of difficulty while not finding a difference in feelings of negativity based on said strategies. I have provided a couple of ideas that may help explain this finding, including that effort may be inherently aversive, and that just because participants indicated more effort for certain strategies, does not mean that this equated to greater success.

Emotion Regulation Choice Doesn't Depend on Timing

Lastly, in my second experiment I investigated how people choose to regulate their emotions when given the choice. Specifically, I looked at how proactive versus reactive cueing influenced which strategies participants would choose and found that there were no differences in strategy choice between proactive and reactive trials. To my knowledge, this was the first test of emotion regulation choice using the dual-mechanisms of cognitive control framework. Contrary to my hypotheses, suppression was not used more often in the reactive condition, and

reappraisal was not used more often in the proactive condition. A potential implication of this finding is that people are equally likely to choose reappraisal as they are to choose suppression in either proactive or reactive conditions. One explanation for this could be that the proactive and reactive conditions did not influence how difficult the task felt, and so participants choose the strategy they wanted to use based on other factors beyond difficulty. A recent meta-analysis (M. Matthews et al., 2021) provided an overview of the determinants of emotion regulation choice, as well as determinants of intentions to regulate at all. One study (Wood et al., 2009) found that participants intentions (future plans) to regulate their emotions was greater for negative compared to neutral emotions, suggesting that valence plays a role in choice. This effect may be represented in my data via the two-way interaction between valence and response on regulation choice. I observed that participants used reappraisal more for negative images compared to neutral images, possibly suggesting that participants were more willing to regulate more for negative compared to neutral images. Milyavsky et al. (2019) found that participants chose to use reappraisal more when cognitive effort (manipulated within the study) was low compared to when it was high. However, this effect was not replicated in my data since there was no difference in emotion regulation choice based on proactive (i.e., low cognitive effort) versus reactive (i.e., high cognitive effort) strategy cueing.

Strengths and Limitations

While there are several limitations to my study, I will only discuss a couple that I believe are the most important. The first is that my design assumes that participants follow through with the strategies that they were instructed to use or that they chose to use. While this limitation was addressed in my second experiment, I think that there is still a degree of uncertainty when it comes to understanding whether participants genuinely made use of the strategies. For example,

in E2 I found that overall compliance was around 80% for all trials, but that some participants complied as little as 0% of the time. However, given that compliance scores are based on subjective responses, it is possible that participants were not always being honest, and impossible to confirm that they were genuinely using the strategies. The majority of emotion regulation studies find that the strategies make at least some impact on emotion experiences, and so it is quite jarring to observe here that there was no effect of strategy on negativity in either experiment. If participants did not use the strategies that they were instructed to in E1 and if participants were not honesty about the strategies that they choose to use in E2, then the data regarding the influence of these strategies on feelings of negativity and difficulty are invalid. This assumption of participant compliancy is not unique to my studies design, but could be, in my opinion, a major source of unaccounted variance in emotion regulation designs. A second assumption made in my study was that was that participants experienced negative emotion to the extent that attempting to regulate said emotion was possible. While I did observe that participants felt more negative during the negative trials compared to the neutral trials, it is hard to confirm that these feelings of negativity were strong enough to motivate participants to make use of the instructed or chosen strategy. One reason I suggest this is that in E2, participants chose to just look at the images for around 40% of all trials; one can imagine that if a person felt a strong negative emotion, they would be motivated to try something to change that emotion. Based on these two assumptions, the validity of my findings are limited as is their generalizability, but they do provide an interesting starting point for future inquiries.

The last limitation of my studies that I will discuss is sample size in E2. E2 only had 30 participants, but my power analysis suggested that sample size should be at least $N = 50$ to detect a small effect size for my factorial design. Consequently, while the study was adequately

powered to detect medium effect sizes, it lacked the statistical power to reliably identify small effects. It is also possible, of course, that the significant effects found in the first experiment were due to a Type 1 Error, and that my second experiments' results reflect this. It is hard to compare the two experiments because the sample sizes are substantially different. However, I do have some confidence in my second experiment's power since I failed to replicate a basic emotion regulation finding (the main effect of strategy on feelings of negativity) across both experiments. Beyond my thesis, I am continuing to collect data and plan to reach my desired sample size prior to writing the results up for publication.

My study also had several strengths, including that it was a fully crossed within subjects design maximizing power, that the images were chosen systematically using an algorithm maximizing experimental control of the stimuli, and it was the first purely behavioural test of the proactive and reactive emotion regulation account proposed by Martins-Klein et al. (2020). I was also able to account for the assumption that participants were compliant in the study to some degree by designing my second experiment to ask participants to indicate which strategy they used on each trial. Finally, I ran two experiments to test the reliability of my results, providing a more rigorous test of my hypotheses.

Future Directions

To address the limitations of my study and provide a better test of my hypotheses, I have several suggestions for future research. To address the issue of not knowing how well participant were complying, I recommend having participants either verbally talk through each strategy they used (as in Sheppes et al., 2011), or having participants type out which strategy they used and how they used it. While this may make the task slightly more difficult, it would provide a better estimate of the degree that participants followed through with using the different strategies as

well as greater confidence in their subjective responses since they would have to elaborate on the way that they used the strategy (as opposed to just pressing a key to indicate which strategy they used).

Next, to address the issue of emotion induction, I would suggest using a form of emotion induction that is specific to the participant, rather than selected from a list of images that may or may not elicit an emotion. Pascual-Leone et al. (2016) suggest that one way to do this is by tailoring the emotion stimulus to be subjectively relevant to each participant. For example, having participants coming into the lab once to assess what kinds of stimuli evoke an emotional response in them, and once to complete the emotion regulation task with said stimuli. Hopefully, this would increase the degree of similarity in emotion responses between participants, decreasing the potential variance in how emotional participants each feel. The ultimate goal would be to elicit approximately the same type of emotion (either positive or negative) to the intensity (low to high arousal), minimizing the difference in emotion induction between participants (and therefore reducing the amount of unaccounted variance).

Lastly, not in relation to any of the limitations of my study, I would like to test my hypotheses using a trial design that more closely reflects that of the AX-CPT (Braver, 2012). One example of this is to change the emotion regulation trial design, where the instruction cue is presented twice on every trial and is either the same cue both times (benefitting from proactive control) or one cue the first time and a different on the second presentation (benefitting from reactive control). I could then elicit biases in either proactive or reactive control by making the majority of the trials have the same cue twice, or majority of the trials having a different cue the second time, respectively. If the majority of the trials were proactive, I would expect to see better

efficacy for proactive trials compared to reactive trials, demonstrated via lower feelings of negativity and lesser feelings of difficulty, and vice versa for a majority of trials being reactive.

Conclusion

In conclusion, my two experiments provide mixed evidence for the effect of proactive versus reactive strategy usage on emotion regulation efficacy and provide no evidence for the effect of proactive versus reactive cueing on emotion regulation choice. However, this conclusion comes with a caveat because I found no evidence that participants benefitted from using the emotion regulation strategies at all. Therefore, more research is needed to specifically test my hypotheses, and to generally test the proactive and reactive emotion regulation framework proposed by Martins-Klein et al. (2020). Specifically, I have suggested that future studies should (a) have participants report what strategy they used by describing what it was and how they used it either aloud or via keyboard, (b) use a form of emotion induction that is relevant to the participant, and (c) try a new task design where the ratio of proactive versus reactive trials is different, biasing participants to expect either proactive or reactive trials more, and thereby eliciting proactive versus reactive cognitive control usage. My experiments provided evidence against the effectiveness of using reappraisal and suppression to regulate emotions, adding to the heterogeneity that exists in research regarding strategy efficacy. Given the limitations of my studies, I am hesitant to generalize my findings to how individuals regulate their emotions in everyday life. I do think that the evidence presented here provides further reason to continue examining the efficacy of emotion regulation strategies in general and the effect of timing on emotion regulation efficacy specifically.

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Appendix A

Data Used to Calculate Power

3 x 2 x 2 Within-Subjects Design

	Small Effect Size	Medium Effect Size
Condition	*M*	*M*
Proactive		
Reappraise-Neutral	1	1
Reappraise-Negative	1.9	1.5
Suppress-Neutral	1	1
Suppress-Negative	3	4
Watch-Neutral	1	1
Watch- Negative	5	5
Reactive		
Reappraise-Neutral	1	1
Reappraise-Negative	3	4
Suppress-Neutral	1	1
Suppress-Negative	2	2.5
Watch-Neutral	1	1
Watch- Negative	5	5

Note. Means (*M*) represents participants average rating on how negative they feel. For small effect size, $N = 55$, SD = 2 and $r = .3$. For medium effect size, $N = 35$, SD = .999, $r = .2$.

3 x 2 Within-Subjects Design

Condition	Small Effect Size	Medium Effect Size
	M	*M*
Proactive		
Reappraise	4	1.5
Suppress	6.5	5
Watch	8	7
Reactive		
Reappraise	4.5	3
Suppress	6	3
Watch	8	7

Note. Means represent participants average rating on how negative they feel. For small effect size, $N = 50$, SD = 1.3 and $r = .3$. For medium effect size, $N = 30$, $SD = 2.5$, $r = .25$.

Appendix B

Emotion Regulation Instructions

Before each picture, you are going to see one of three instructions which tells you what you are going to do while the picture is on the screen. The first instruction you might see is the WATCH instruction. When you see the instruction to WATCH, we want you to look at the picture, keep your eyes on it the whole time, and allow yourself to respond naturally to it. So have whatever thoughts and feelings you would naturally have in response to that picture. Another instruction you will see is SUPPRESS. When you see the instruction to SUPPRESS you will try to hide how you feel about the picture you see, so that if someone were observing you they couldn't tell that you were feeling any emotion. Another instruction you will see is REAPPRAISE. When you see the instruction to REAPPRAISE we want you to either think of something to tell yourself that helps you to feel less negative about the picture (rethink). For example, when you rethink, you could tell yourself something about the outcome, so that whatever is going on will soon be resolved, or that help is on the way. Another instruction you will see is CHOOSE. When you see the instruction to CHOOSE we want you to choose to either reappraise, suppress, or watch while viewing the image After each picture, you will see a scale like this which will ask you to indicate how negative you feel: It goes from 1 to 5, where 1 means that you don't feel negative at all, and 5 means that you feel strongly negative. 2, 3, 4 are in between. We realize that sometimes you won't feel negative at all, sometimes you might have started to feel negative and then tried to decrease how negative you felt and that worked really well, and sometimes you attempt to decrease how negative you feel but couldn't think of something in time or it didn't really work that well. No matter what happened through the course

of looking at the picture, try to rate at the end how negative you feel when all is said and done, so where you ended up after all you tried to do. Try to be as honest as you can about how you feel.

*E1 will not include the instructions about the CHOICE trials.

Appendix C

Positive and Negative Affective Schedule (Watson et al., 1988)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you felt this way today. Use the following scale to record your answers.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

	Interested	Irritable
	Distressed	Alert
	Excited	Ashamed
	Upset	Inspired
	Strong	Nervous
	Guilt	Determined
	Scared	Attentive
	Hostile	Jittery
	Enthusiastic	Active
	Proud	Afraid

Appendix D

Emotion Regulation Questionnaire (Gross & John, 2003)

Instructions and Items

We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1----------2----------3----------4----------5----------6----------7

Strongly Disagree Neutral Strongly Agree

1. ____ When I want to feel more positive emotion (such as joy or amusement), I change what I'm thinking about.

2. ____ I keep my emotions to myself.

3. ____ When I want to feel less negative emotion (such as sadness or anger), I change what I'm thinking about.

4. ____ When I am feeling positive emotions, I am careful not to express them.

5. ____ When I'm faced with a stressful situation, I make myself think about it in a way that helps me stay calm.

6. ____ I control my emotions by not expressing them.

7. ____ When I want to feel more positive emotion, I change the way I'm thinking about the situation.

8. ____ I control my emotions by changing the way I think about the situation I'm in.

9. ____ When I am feeling negative emotions, I make sure not to express them.

10. ____ When I want to feel less negative emotion, I change the way I'm thinking about the situation.

Note

Do not change item order, as items 1 and 3 at the beginning of the questionnaire define the terms "positive emotion"and "negative emotion".

Scoring (no reversals)

Reappraisal Items: 1, 3, 5, 7, 8, 10; Suppression Items: 2, 4, 6, 9.

Appendix E

Attentional Control Scale (Derryberry & Reed, 2002)

Here are some different ways that people can feel about working and concentrating. Please indicate how strongly each statement applies to you. R = reverse-scored item.

1 = Almost never
2 = Sometimes
3 = Often
4 = Always

1. It's very hard for me to concentrate on a difficult task when there are noises around. (R)	1 2 3 4
2. When I need to concentrate and solve a problem, I have trouble focusing my attention. (R)	1 2 3 4
3. When I am working hard on something, I still get distracted by events around me. (R)	1 2 3 4
4. My concentration is good even if there is music in the room around me.	1 2 3 4
5. When concentrating, I can focus my attention so that I become unaware of what's going on in the room around me.	1 2 3 4
6. When I am reading or studying, I am easily distracted if there are people talking in the same room. (R)	1 2 3 4
7. When trying to focus my attention on something, I have difficulty blocking out distracting thoughts. (R)	1 2 3 4
8. I have a hard time concentrating when I'm excited about something. (R)	1 2 3 4
9. When concentrating I ignore feelings of hunger or thirst.	1 2 3 4
10. I can quickly switch from one task to another.	1 2 3 4
11. It takes me a while to get really involved in a new task. (R)	1 2 3 4
12. It is difficult for me to coordinate my attention between	1 2 3 4

the listening and writing required when taking notes during lectures. (R)

13. I can become interested in a new topic very quickly when I need to.	1	2	3	4
14. It is easy for me to read or write while I'm also talking on the phone.	1	2	3	4
15. I have trouble carrying on two conversations at once. (R)	1	2	3	4
16. I have a hard time coming up with new ideas quickly. (R)	1	2	3	4
17. After being interrupted or distracted, I can easily shift my attention back to what I was doing before.	1	2	3	4
18. When a distracting thought comes to mind, it is easy for me to shift my attention away from it.	1	2	3	4
19. It is easy for me to alternate between two different tasks.	1	2	3	4
20. It is hard for me to break from one way of thinking about something and look at it from another point of view. (R)	1	2	3	4

Appendix F

Attentional Control: Distraction and Shifting Scales (Carriere et al., 2013)

For the following statements please select the response that most accurately reflects your everyday attentional control ability.

Almost never (1) to Always (5)

1. I have difficulty concentrating when there is music in the room around me
2. When I am working hard on something, I still get distracted by events around me
3. It's very hard for me to concentrate on a difficult task when there are noises around
4. When I am reading or studying, I am easily distracted if there are people talking in the same room
5. I am slow to switch from one task to another
6. It takes me a while to get really involved in a new task
7. It is difficult for me to alternate between two different tasks
8. After being interrupted, I have a hard time shifting my attention back to what I was doing before.

Scoring (no reversals)

Distraction Items: 1, 2, 3, 4; Shifting Items: 5, 6, 7, 8.

Appendix G

NASA Task Load Index (Hart & Staveland, 1988)

Scale from 0 (very low) to 100 (very high)

Mental Demand

How mentally demanding was the task?

Physical Demand

How physically demanding was the task?

Temporal Demand

How hurried or rushed was the pace of the task?

Performance

How successful were you in accomplishing what you were asked to do?

0 = failure / 100 = success

Effort

How hard did you have to work to accomplish your level of performance?

Frustration

How insecure, discouraged, irritated, stressed, and annoyed were you?

Motivation

How motivated were you to do well on the primary task?

Appendix H

Consent Form

Research Project Title: Cognitive Control and Emotions

Principal Investigator:

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Co-Investigator:

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This consent form, which you are encouraged to take a copy of for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Study Overview

Purpose: The research is being conducted to gain more knowledge about emotion and cognition.

Procedures: The experiment will involve one session lasting approximately 60 minutes. The specific task will involve the following:

1. Filling out questionnaires about your feelings and behaviours.
2. Perform a keypress task. The tasks involves being presented with a visual stimulus and making a keyed response. The stimulus will be an image, and could be positive (e.g., a picture of a puppy) or negative (e.g., a picture of a sad child). You will be required to make a response to the questions by using the computer keyboard. Unless instructed otherwise please be as quick and accurate as possible when making responses.

Benefits: Although it will not directly benefit you, this study will advance basic science on emotion and cognition.

Potential risks: You may feel uncomfortable due to the nature of the images.

Data privacy and confidentiality: All personally identifying information will be removed from the data prior to storage on a password-protected lab computer. Only anonymized data will be stored. Any identifiable data will be destroyed by April 1st, 2024. Anonymized data may be shared on a public data repository (e.g., https://osf.io).

Data sharing: Some data and information from this study may be sent outside of the University of Manitoba to other researchers, organizations, or made publicly available. This is for further analysis, testing, as part of the research study, or a requirement by a granting agency or journal. Any information

sent out of the University of Manitoba will not show your name or address, or any other identifiable personal information about you. However, despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

Compensation: You will receive 1 credit for participating in this study. Compensation will be granted through SONA within 48 hours of completing the study.

Voluntary participation and right to withdraw: Participation in this study is voluntary**.** You have the right to withdraw from this experiment at any time. If you wish to withdraw, simply exit the browser (if withdrawing during the experiment) or alert the research assistant. You may also contact us to withdraw after you have completed the experiment and have your data deleted up to March 31st, 2024. If you choose to withdraw at any point, you will still receive your full compensation.

Debriefing: At the end of the study, you will be presented a debriefing screen that will outline the purpose and hypothesis of the study.

Dissemination: Results of this study will be published in an aggregate form in a scientific journal. Anonymized data may be shared on a public data repository (e.g., https://osf.io). The results of this study will also be included in Stephanie Souliere's master's thesis.

Summary of results: During the debrief, you will be provided a website link that will direct you to a summary of the results. The results of the study will be available at that link by April 2023.

Clicking 'A cognitive control EPT' indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way. This research has been approved by the Research Ethics Board at the University of Manitoba, Fort Garry campus. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Officer at 204-474-7122 or HumanEthics@umanitoba.ca. A copy of this consent form has been given to you to keep for your records and reference.

[Participants will be presented two buttons: A cognitive control EPT or DECLINE]

Appendix I

Demographic Questions

1. Please indicate your age:
Self-describe (text input).

2. What is your gender?
Self-describe (text input)

3. What is your ethnicity? Examples with brackets are not complete; other groups are possible within categories. If you would like to choose more than one option, you are free to do so.
    a. Arab
    b. Black
    c. Chinese
    d. Filipino
    e. Indigenous (First Nations, Métis, Inuk)
    f. Japanese
    g. Korean
    h. Latin American
    i. South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)
    j. Southeast Asian (e.g., Vietnamese, Cambodian, Laotian, Thai, etc.)
    k. West Asian (e.g., Iranian, Afghan, etc.)
    l. White
    m. Other

Appendix J

Debriefing Form

Thank you very much for participating in this study called "Cognitive Control and Emotion". The purpose of this study was to examine how effective emotion regulation is when people have more or less time to prepare. Previous research suggests that how much time people have to prepare to regulate emotions could be important (Gross, 1998), but this has not been fully explored through the lens of cognitive control specifically (Martins-Klein et al., 2020). In this experiment, we predicted that when people had less time to prepare, emotion regulation would be less effective at decreasing how people feel in reaction to emotional images.

Should you have additional questions you are encouraged to email either the Principal Investigator and/or the Co-Principal Investigator:

Principal Investigator: Stephanie Souliere, Master's Student, Department of Psychology, souliers@myumanitoba.ca
Advisor/Co-Prinicpal Investigator: Dr. Nicholaus Brosowsky, Assistant Professor, Department of Psychology, nicholaus.brosowsky@umanitoba.ca
If you have any questions about your rights as a research subject, you may contact the Office of Research Ethics & Compliance at humanethics@umanitoba.ca.
A summary of the results of this study will be posted at this link after August 1st, 2024: https://osf.io/jacp7/. If you would like to see the results, please save or bookmark this link and visit it after August 1st.
If you feel physically unwell after completing the study and would like immediate medical attention, please go to or contact the University Health Service Fort Garry located at 100 UMSU University Centre (phone number: 204-474-8411).
If you found that the images in the study were distressing or upsetting and would like to be in contact with someone immediate to find help, please go to or contact the UM Student Counselling Centre, located at 474 UMSU University Centre (phone number: 204 474-8592).
If you found that the images in the study were distressing or upsetting and would like to access mental health resources, please see the list below.
Canadian Crisis Hotline –

- Call 1-888-353-2273

Crisis Service Canada –

- Call (24/7) 1-833-456-4566
- Text (3pm -11pm Central Time) 45645

Klinic Crisis Line

- Call (24/7) (204) 786-8686
- Call Toll Free (24/7) 1-888-322-3019

The LifeLine App - www.thelifelinecanada.ca

Manitoba Suicide Line –

- Call (24/7) 1-877-435-7170

University of Manitoba Mental Health - https://umanitoba.ca/mentalhealth/

Further reading:

Gross, J. J. (1998). The Emerging Field of Emotion Regulation: An Integrative Review. Review of General Psychology, 2(3), 271–299. https://doi.org/10.1037/1089-2680.2.3.271

Martins-Klein, B., Alves, L. A., & Chiew, K. S. (2020). Proactive Versus Reactive Emotion Regulation: A Dual-Mechanisms Perspective. 6.