COGNITIVE AND PHYSIOLOGICAL CORRELATES OF EMOTION REGULATION:
IS REAPPRAISAL A TEACHABLE SKILL?

by

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Cognitive and Physiological Correlates of Emotion Regulation: Is Reappraisal a Teachable Skill?

Abstract

by

RACHAEL N. VOLOKHOV

The ability to regulate one’s emotions is an integral part of social behavior. One emotion regulation strategy, known as reappraisal, is characterized by cognitively evaluating an emotional stimulus to reduce its emotional impact. This study was designed to determine what emotion regulation strategies people naturally use in emotional situations and to test whether reappraisal is an ability that can be taught. Participants (50 men, 63 women) were shown a negative and a positive film clip, an experimental group received reappraisal training, and two more negative and positive clips were shown. Participants with high baseline respiratory sinus arrhythmia (RSA) naturally used more reappraisal than those with low RSA, but low RSA participants made greater advances in reappraisal use after training. Increased behavioral inhibition was associated with increased self-reported negative affect and decreased arousal to the negative films, while increased behavioral activation was related to greater sympathetic activation to the positive films.
Introduction

Emotion Regulation

Emotions have been defined as self-regulatory responses that are able to direct behaviors towards a goal (Thayer & Lane, 2000). While largely functional, emotions need to be controlled across a variety of circumstances so that social goals can be achieved. In addition, the proper regulation of emotional processes is vital to mental health as well as physical well-being (Gross, 1998). For example, many affective disorders are characterized by emotional inflexibility (DSM-IV; Gross, 1998).

A model proposed by James Gross (Gross, 1998; John & Gross, 2003) has been largely accepted by researchers in the field of emotion regulation. This model divides regulation into two broad categories: antecedent-focused and response-focused strategies. Antecedent strategies encompass the processes enacted before an emotion is fully experienced; an individual is manipulating the emotional input in the cognitive domain (Gross, 1998). For example, one may purposefully redirect one’s attention away from an emotional stimulus or avoid an emotionally charged situation altogether. Response-focused strategies are enacted once the emotion has already been felt; the goal is to manipulate output (Gross, 1998). Use of response-focused strategies usually involves muscular control of behavioral (often facial) expressions. One of the salient differences between these two approaches is the time when the strategy is initiated relative to when the internal emotion is felt (John & Gross, 2003). Specifically, reappraisal is initiated before peak emotion is felt and suppression is initiated during or after peak emotional experience.
The most researched antecedent strategy is known as reappraisal. Gross (1998) described reappraisal as redefining the emotional stimuli in unemotional terms or thinking about a potential emotion situation in a different way to change the emotion’s impact on the self. Either way, reappraisal is a cognitively oriented strategy. Likewise, the response-focused strategy most investigated is called suppression and is described as the inhibition of emotion expression during a felt emotion (John & Gross, 2003). Suppression is behavior oriented. These two prototypical strategies can be differentiated in a number of ways.

While reappraisal and suppression are both successful at reducing facial expression, only reappraisal has been shown to decrease internally felt negative emotion (Gross, 1998, 2002; Gross & Levenson, 1993, 1997). In fact, reappraisal decreases both negative and positive felt emotion, but suppression only decreases positive emotion (Richards & Gross, 2000). In the cognitive domain, people who suppress their emotions do worse on simultaneous cognitive tasks (Richards & Gross, 1999) as well as subsequent tasks (Schmeichel, Demaree, Robinson, & Pu, 2006). Suppression has also been associated with memory impairment. For example, Richards & Gross (2000) found verbal memory impairment in participants who suppressed their emotions while watching a negative film. The chronic use of suppression may actually lead to self incongruence (Gross & John, 2003) or ‘expressive dissonance’ (Robinson & Demaree, 2007). Robinson & Demaree (2007) instructed participants to facially express the opposite of what they felt internally. This created dissonance between their emotional state and their behavioral expression, which resulted in increased subsequent arousal and subsequent memory impairment.
While many researchers choose to study these strategies by instructing participants to use either suppression or reappraisal, it is equally important to examine spontaneous, or automatic, regulation. Automatic regulation can be divided into two types: 1) implicit ideas or goals a person has about emotion regulation and 2) regulation behaviors that people use during emotional situations (Mauss, Cook, & Gross, 2007). Research on automatic regulation is in its infancy. This study will incorporate automatic regulation by allowing participants to initially regulate their emotions as they see fit. This decision was influenced by a study conducted by Demaree, Robinson, Pu, and Allen (2006) which investigated if participants actually use the strategy as instructed by the experimenter. Using a post-experiment questionnaire, they found that at least half of the people told to suppress used at least some cognitive strategy as they watched either a positive or negative film clip. Demaree and colleagues suggested that reappraisal instructions may benefit from increased specificity, a recommendation implemented in the proposed study. Researchers in the past have invariably used single sentences to describe suppression and reappraisal, but people may forget or not fully understand what they are asked to do. People instructed to suppress may use reappraisal automatically if they are habitual reappraisers, and vice versa. This idea is supported by Egloff, Schmukle, Schwerdtfeger & Burns (2006) who reported that some people seem to favor reappraisal or suppression, use a combination of both, or use neither strategy.

Physiological Factors

As previously alluded, emotion regulation is closely tied to psychological and physiological well-being. Using the number of skin conductance responses a participant experiences as a measure of sympathetic arousal, researchers have repeatedly
demonstrated that suppression (but not reappraisal) causes increased sympathetic activation (e.g., Demaree, Pu, Robinson, Schmeichel, & Everhart, 2006; Demaree, Schmeichel, Robinson, Everhart, 2004; Demaree, Schmeichel, Robinson, Pu, Everhart & Bernston, 2006; Gross, 1998, 2002; Gross & Levenson, 1997). An electrodermal response (EDR) occurs when skin conductance suddenly increases—a measurable event. Long term physiological effects of suppression have been reported as well; inexpressiveness may accelerate the progression of cancer in an individual (Gross, 1989) and chronic anger suppression has been associated with cardiovascular disorders such as hypertension since before WWII (Alexander, 1939).

A commonly used physiological measure is respiratory sinus arrhythmia (RSA). RSA can be defined as the degree to which heart rate accelerates during inspiration and slows during exhalation (Bernston et al, 1997). As part of the parasympathetic branch of the autonomic nervous system, RSA is influenced by vagus nerve functioning (Katona, Poitras, Barnett, & Terry, 1970; Lumbers, McCloskey, & Potter, 1979). RSA is used as a noninvasive method of measuring cardiac vagal tone, which is the mean level of vagal effect (i.e. the effect of the vagus nerve) on the heart (Bernston et al, 1997). High vagal tone has been associated with several positive characteristics, such as self regulatory ability, flexibility, and adaptability (Thayer & Lane, 2000). Chronically low parasympathetic tone indicates an inflexible & unhealthy person and has been associated with a variety of negative outcomes such as generalized anxiety disorder, panic disorder, cardiovascular disease, hostility, and death (Thayer & Lane, 2000). In addition, decreased cardiac vagal control has been linked with depression symptoms (Carney et al, 2000).
RSA has been positively correlated with greater attentional control (Pu & Demaree, submitted). Research conducted with infants has revealed a connection between high RSA and increased attention to novel stimuli, as well as resistance to distraction (Richards, 1987). The ability to choose and maintain attention is critical to emotion regulation (Porges, 1992); in fact, attention control was previously given as a type of antecedent-focused regulation strategy.

RSA can predict an individual’s ability to control their expression when exposed to negative stimuli. Higher vagal control is associated with less negative facial expression to negative films (Demaree, Pu, Robinson, Schmeichel, & Everhart, 2006) and lower RSA indicates greater emotional display and decreased ability to regulate to negative (but not positive) stimuli (Demaree, Robinson, Everhart, & Schmeichel, 2004). In addition, Pu & Demaree (submitted) found that while people with high baseline RSA had bigger differences between felt emotion and facial expression, they also had worse reaction time than controls on a spatial working memory task.

In a study by Demaree, Pu, Robinson, Schmeichel, and Everhart (2006), 94 Case undergraduates were told to watch either a positive or negative two minute film. No instructions on how to watch were given. RSA and EDR were measured during a two minute baseline and while they watched the clip. Subjects were videotaped and their expressions were later coded for valence. The negative film was of an animal slaughterhouse and the positive was of a comedian’s monologue. The Self-Assessment Manikin (SAM), a pictorial scale of current emotion levels, was used as a self-report measure of felt emotion. As expected, individuals with higher RSA showed less facial emotion to the negative film than those with low RSA. Demaree and colleagues (2006)
found that higher RSA individuals felt no less negative emotion or sympathetic arousal, so the decreased facial expression was not due to increased use of reappraisal or to RSA reactivity. They also reported that baseline RSA predicted RSA reactivity to the negative film only. The proposed study is expected to replicate these findings (high RSA participants will be able to control their expressions to the negative film), and further anticipates that participants with higher baseline RSA will be more likely to use reappraisal after a short emotion regulation training session.

One drawback of using RSA as a physiological measure is its susceptibility to respiration rate (Ritz, Thons, & Dahme, 2001). To control respiration rate, a technique known as ‘paced breathing’ may be employed in which a baseline measurement of RSA is taken while the participant is instructed (via auditory or visual signals) when to breathe in and breathe out (Houtveen, Groot, & de Geus, 2005). This control removes any potential artifacts and allows for inter-individual comparisons of RSA.

In addition to purely physiological measures, self report scales offer another perspective on internal processes. The behavioral inhibition and activation scale (BIS/BAS) is one such measure. The BIS/BAS scale was developed by Carver and White (1994) and is composed of 20 questions. The BAS subscale is associated with approach behavior, positive affect, left frontal lobe brain activation, and trait PA (positive affect), while the BIS subscale is associated with behavioral inhibition, withdrawal responses, negative affect, right frontal lobe brain activation, and trait NA (Corr, 2001; Demaree, Robinson, & Everhart, 2005; Harmon-Jones & Allen, 1997; Mathews & Gilliland, 1999; Sutton & Davidson, 1997). The BIS/BAS scale can be used in conjunction with measures of sympathetic activation (i.e. electrodermal responses).
Scores on the BIS/BAS scale can be related to the number of EDRs that occur while individuals experience negative or positive emotions, respectively.

The Social Aspect

It is within a social context that the regulation of emotion is often essential. People not only regulate their emotions to maintain relationships with others or in the pursuit of social goals (Gross & John, 2003), but emotion regulation can influence the tone of a social interaction (Lopes, Salovey, Beers, & Cote, 2005). This point is illustrated in a study conducted by Butler et al (2003) in which dyads viewed a negative film and subsequently discussed it with each other. One of the two participants had been secretly asked to suppress, reappraise, or naturally watch the negative film. Butler and colleagues found that interacting with someone who was suppressing their emotions was more stressful (based on blood pressure readings) compared to someone reappraising their emotions. This study indicates that emotion regulation not only influences the person regulating, but directly impacts those they communicate with on a social level.

The two emotion regulation strategies described earlier, reappraisal and suppression, seem to have differential social outcomes. High reappraisal use has been positively correlated with sharing one’s emotions with others, having closer relationships with others, and higher peer ratings (Gross & John, 2003). In stark contrast to this picture of social health, habitual suppressors are less likely to share emotions, report a lack of closeness in relationships, and have neutral peer ratings (Gross & John, 2003). These results suggest that habitual suppressors may receive less social support from others and have lower self esteem; this may snowball into less effective coping, less life
satisfaction, and more rumination, ultimately culminating in depressive symptomology (Gross & John, 2003).

Research with children has yielded similar findings. Eisenberg, Fabes, Guthrie and Reiser (2000) found that emotion regulation ability in children was positively associated with their level of social functioning. Moreover, these children were viewed more favorably by their peers. In a longitudinal children’s study, children who were deemed high in ‘effortful control’ (i.e. voluntary emotion regulation via attention regulation and planning) were more likely to engage in prosocial behavior, seen as socially more competent, and were more popular with both their peers and teachers (Spinrad et al, 2006). In addition, high correlations were found between effortful control and social competence (Spinrad et al, 2006).

Given the role that social interactions play in emotion regulation, it is not surprising that individuals desire to ‘put their best face forward’ when in emotionally charged situations. This need for individuals to respond in a socially and culturally approved manner has been termed ‘social desirability.’ A popular measure of social desirability is the Marlowe-Crowne Social Desirability Scale (MCSD; Crowne & Marlowe, 1960), a short questionnaire of 33 true/false items that determine how much a person wishes to present themselves in a socially positive light. This study will utilize the MCSD to determine if social desirability is related to spontaneous emotion regulation and the implied request to use reappraisal as a regulation tool.

From the preceding sections, it is clear that reappraisal is a far superior strategy of emotion regulation, as seen in the cognitive, physiological, and social domains. One reason suppression may be so costly is because it occurs alongside the emotion and
requires continuous self-monitoring and corrective behavior to maintain control (Gross, 2002). Another finding that supports reappraisal’s superiority is that the preference for antecedent response strategies increases with age (John & Gross, 2004). This may indicate that people actually learn that reappraisal is better as they gain more emotional experience. A word of caution is called for: reappraisal is a better strategy only as long as it is flexible and realistic (Gross, 1998). For instance, it is not adaptive for people in abusive relationships to cognitively evaluate their situation in a positive light because this may lead the victim to accept their abuse and downplay its destructiveness. Suppression is an equally maladaptive strategy in this example. However, in most social situations requiring emotion regulation, reappraisal seems to be a healthier choice.

The Role of Intelligence

Emotional intelligence (EI) has been proposed to explain the varying degrees of emotion regulation ability seen across individuals. Schutte et al (1998) described EI as ‘being able to attend rapidly, appropriately, and effortlessly to feelings.’ Research on EI can be divided into two realms: trait EI research is based on self-report measures and draws heavily on personality, while information-processing EI research is far more objective and cognitively based (Petrides & Furnham, 2000). Regardless, EI has been related to such diverse qualities as empathy, self-esteem, life satisfaction, extraversion, openness, relationship quality, and mood management (Ciarrochi, Chan, & Caputi, 2000). High EI seems able to reduce stress for some people only; others with high EI may suffer because they don’t have confidence in their own emotional ability (Gohm, Corser, & Dalsky, 2005). In contrast, low EI may lead to deficient emotion perception or emotion labeling, leading to poor emotional communication, behavior problems, and delayed
social competence (Izard, 2001). For instance, Crick and Dodge (1996) reported that aggressive children tend to attribute hostility to other’s actions; they are incorrectly labeling others’ emotions and inadvertently contributing to the cycle of behavioral problems.

A hierarchical model of EI was developed by Salovey and Mayer in 1990. Their model divided EI into three areas: 1) emotional appraisal and expression, 2) emotion regulation, and 3) use of emotion information in cognitive/behavioral problem solving. In 1997, Salovey and Mayer restructured their original theory to produce the ‘ability model of EI’, a model widely accepted by other EI researchers. This model is strongly cognitive (versus mixed models which incorporate personality variables) and is comprised of four branches: 1) perception, appraisal, and expression, 2) emotional facilitation of thinking, 3) understanding, analyzing, and employing emotional knowledge, and 4) reflective regulation of emotion to further emotional an intellectual growth. Of these four branches, emotion regulation is seen as the most complex and requiring the greatest cognitive effort. Additionally, each branch is composed of different ability levels organized in a stepwise manner. That is, one must master one step before going to the next.

Several methods to measure EI have been forwarded. Along with their theory, Salovey and Mayer (1990) created a largely objective measurement system to determine an individual’s EI (known as the MEIS), however, Roberts, Zeidner, and Matthews (2001) claimed that the MEIS doesn’t have predictive validity once you control for IQ and personality. A more recent version of the MEIS, the MSCEIT, has been developed (Mayer, Salovey, & Caruso, 2003) but has undergone insufficient peer evaluation.
One of the more popular trait-style EI measurements was created by Bar-On (1996). This 133 item scale has fifteen subscales designed to measure: emotional self-awareness, assertiveness, self-regard, self-actualization, independence, empathy, interpersonal relationships, social responsibility, problem solving, reality testing, flexibility, stress tolerance, impulse control, happiness, and optimism. Many of these subscales seem unrelated to traditional definitions of EI. Schutte et al (1998) tried their hand at creating a valid EI measurement system, yet left over 80% of the total variance unexplained (Petrides & Furnham, 2000). Interestingly, Schutte et al (1998) found that females had higher EI scores than men and that EI was positively associated with Openness on the Big Five. Yet, these findings are suspect considering the measure’s shortcomings. Finally, a measurement scale was developed by Gross and John (2003) which focused on not on EI as a whole but on emotion regulation only which they labeled the ERQ. They found that men scored higher on the suppression subscale than women and that European Americans showed the least use of suppression compared to ethnic minorities (Gross & John, 2003); no gender or ethnic differences were found with reappraisal.

EI researchers have worked diligently to establish EI’s place in the intelligence arena. Petrides & Furnham (2000) argued that EI may be a component of overall intelligence but others point towards studies that show no relationship between EI and IQ (Ciarrochi, Chan, & Caputi, 2000). Furthermore, research shows that infants can identify and discriminate between emotions, so EI may not be based on cognitive development (Caron & Caron, 1988).
Though emotion regulation strategies are central to theories of EI, Gross and John (2003) found that (based on SAT scores) reappraisal and suppression were not related to intelligence. However, Schmeichel, Volokhov, and Demaree (submitted) did find a relationship between emotion regulation and working memory, a component of intelligence. People with superior working memory were able to control their emotions better to both positive and negative emotional stimuli (Schmeichel, Volokhov, & Demaree, submitted). In addition, they used reappraisal more successfully than people with low working memory, so that both felt emotion and emotional expressions were reduced.

Regardless of the possible relationship between natural emotion regulation ability and intelligence, intelligence may still play an important role in the ability to learn a particular regulation strategy. This study examines this possibility by comparing reappraisal use before and after emotion regulation training. Participants’ SAT scores were collected as a measure of IQ (Frey & Detterman, 2004). Past researchers have found a correlation between high IQ and the rate of learning (Gettinger, 1984). In addition, the ability to learn concepts is more g-loaded than rote memorization or trial-and-error learning (Jensen, 1998). Together, these statements point towards higher IQ individuals being able to quickly pick up a concept such as reappraisal and apply it to future situations more easily than lower IQ individuals.

Study Overview

Participants were first given a series of questionnaires designed to assess their level of social desirability, emotional intelligence, and behavioral inhibition/behavioral activation. They were physiologically monitored during a two minute baseline and while
viewing a positive and negative film clip. A short emotion regulation training session followed. This session explained different regulation strategies and stressed the superiority of reappraisal. After training, another set of positive and negative clips were presented. Immediately after every clip, participants were asked questions about which regulation strategies they used during the film (if any) and their affective response to the film. Participants also allowed Case Western Reserve University to release their SAT scores for later analysis on the role of intelligence in learning regulation strategies.

Hypotheses

1. Participants with higher baseline RSA will show less facial expression to the negative clip, but not the positive clip, both before and after reappraisal training. This hypothesis predicts a replication of previous findings regarding RSA and facial control.

2. Participants with higher baseline RSA will be more likely to use reappraisal as an emotion regulation strategy after reappraisal training. Because high RSA is associated with helpful traits like adaptability, flexibility, and self-control, it is predicted that high RSA is related to the use of a helpful emotion regulation strategy such as reappraisal.

3. Participants with higher scores on the social desirability scale will use more reappraisal in response to the negative film clip before and after reappraisal training. An interaction effect will occur after the training session; specifically, use of reappraisal will increase the most for participants with relatively high levels of social desirability.

4. In addition, participants with higher reappraisal scores on the ERQ will use reappraisal more than those with lower scores both before and after reappraisal training. An interaction effect will occur after the training session such that persons with high
scores will be associated with the greatest increase in reappraisal use. In essence, what people report on the ERQ should match their actual behavior to the film clips.

The next four hypothesis are based on previous studies which found relationships between BIS/BAS, self-reported emotion, and sympathetic activation.

5. Participants with higher BIS scores will have greater levels of self-reported negative emotion to the negative films both before and after reappraisal training.

6. Persons with higher BIS scores will exhibit greater sympathetic activation (as measured by electrodermal response) to the negative film both before and after reappraisal training. This effect will be mediated by self-reported emotion.

7. Participants with higher BAS scores will have greater levels of self-reported positive emotion to the positive films both before and after reappraisal training.

8. Persons with higher BAS scores will exhibit greater sympathetic activation (as measured by electrodermal response) to the positive film than to the negative film both before and after reappraisal training.

9. There will be a positive correlation between SAT score and the successful use of reappraisal to both the positive and negative film clips following the training session. People with high SAT scores should be able to learn reappraisal faster and immediately implement reappraisal during the post-training films.
Method

Participants

Participants in study were Case Western Reserve University undergraduates who were enrolled in an Introductory Psychology class. Students received course credit for their participation in this study.

Emotion-eliciting stimuli

Four film clips were shown to participants in this study. Two were of a negative nature and two were positive. The order in which film clips were shown was counterbalanced across participants. One of the negative clips concerned a child with a rare and serious medical condition and the second clip included scenes from an animal slaughterhouse. The two positive clips were scenes from a comedian’s monologue and television news bloopers. These four films have been successfully used in previous research and reliably generate the target emotions, that is, positive or negative feelings (Schmeichel, Demaree, Robinson, & Pu, 2004; Demaree, Robinson, Pu, & Allen, 2006).

Use of four films was chosen so that subjects would not view the same film twice (before and after training) and thus habituate to the content. During the presentation of each film clip, each participant was videotaped and physiological data recorded. The tape was later rated by two independent coders for emotional content.

Measures (Please see Appendices A-G for copies of these documents.)

1. Demographic and medical history questionnaires. These two questionnaires elicit important demographic information (such as age, gender, and racial background)
and any potential medical issues that may impact the individual’s data inclusion in the study, such as heart problems or certain medications.

2. SAT score release form. This document was included according to the University’s IRB requirements. All University regulations associated with the collection of students’ personal records were followed, especially in regards to confidentiality and data security. SAT scores have been related to IQ and thus will be used as a measure of intelligence (Frey & Detterman, 2004).

3. Emotion Regulation Questionnaire (Gross & John, 2003). The Emotion Regulation Questionnaire (ERQ) is comprised of ten statements divided into two regulation categories; reappraisal and suppression. Responses are based on a 1 (strongly disagree) to 7 (strongly agree) Likert scale. Reliability is reported as .79 for reappraisal and .73 for suppression.

4. Marlowe-Crowne Social Desirability Scale (Crowne and Marlowe, 1960). This social desirability scale, referred to hereafter as the MCSD, consists of 33 true/false items that assess the person’s desire to represent themselves in a positive light to others. The internal consistency of this scale is reported as .88 (Marlowe & Crowne, 1960). Though often used as a covariate, others have used the MCSD as an independent variable. For example, Larson (2000) found that higher MCSD scores predicted women’s desire to conform to social body weight norms (Larson, 2000).

5. BIS/BAS Inventory (Carver and White, 1994). The BIS/BAS scale is composed of 20 questions that measure an individual’s general BIS and BAS inclinations and the strength of those tendencies. Responses are based on a Likert scale scored from 1
to 4, corresponding with ‘strongly agree’ to ‘strongly disagree.’ The internal consistency of BIS/BAS subscales range from .66 to .76 (Carver & White, 1994).

6. The Self Assessment Manikin (Bradley & Lang, 1994). The Self Assessment Manikin (SAM) is a self-report measure composed of two series of pictorial representations. One series represents emotional valence and the other represents arousal levels. The participant must select the valence and arousal levels that best describe how they currently feel.

7. Post-film questionnaire. Following the presentation of each film, participants were asked a series of questions to 1) determine if any emotion regulation strategies were employed, 2) what those strategies consisted of and 3) how effective each strategy was at reducing the emotions experienced.

Procedure

Every participant in this study began by reading and signing an informed consent form. After agreeing to participate, they:

a. Completed the demographic and medical questionnaire, the SAT score release form, the ERQ, the MCSD, and the BIS/BAS scale;

b. Were attached to electrodes (please see Physiological Recording for more information about this procedure);

c.Were given a five minute acclimation period followed by a two minute period in which the instructions “Breathe in” and “Breathe out” appeared on a computer screen at a rate of 15 cycles per minute (Houtveen, Groot, & de Geus, 2005). Physiological data was collected during this period and later used as a baseline;
d. Watched either a positive or negative 2-minute film clip (the order in which clips were shown was balanced across subjects). Physiological data was collected during this period and participants were videotaped;

e. Completed the SAM and the corresponding (either positive or negative) post-film questionnaire, were allowed time to stabilize physiologically, and asked to “sit still and relax” another two minutes;

f. Watched a second film clip (i.e. if the first clip was positive the second was negative, and vice versa) followed by the SAM and corresponding post-film questionnaire;

g. While still attached to electrodes, received training on emotion regulation strategies (see Appendix I), concentrating especially reappraisal, or alternate training about the beginnings of intelligence research (see Appendix J);

h. Were allowed to stabilize and asked to “sit still and relax” once again before watching two more film clips (one positive and one negative) following the same procedure outlined above, including physiological and self-report data collection;

i. Had the electrodes removed and were debriefed (see Appendix H).

Physiological Recording

Participants were tested individually in a quiet (45.00± 0.32 dB) and comfortably lit (about 1300 lux) room. In accordance with the European and American Heart Rate Variability (HRV) Guidelines (Berntson et al, 1997, Task Force, 1996), baseline RSA was measured for the two minutes preceding the film presentation. Paced breathing was used to correct baseline RSA for differences in respiration rate via a visual signal presented on a computer screen over a period of two minutes (Houtveen, Groot, & de
Geus, 2005). A rate of 15 cycles per minute was chosen as a medium rate based on previous experimentation (Houtveen, Groot, & de Geus, 2005).

Tachogram (ECG) data was collected at the standard thoracic sites (the right clavicle and precordial site V6) with disposable Ag-AgCl snap electrodes (Biopac Technologies Model EL503) and digitized at 500 samples per second onto a Dell Optiplex GX200 computer. Data was then amplified by Biopac ECG100C amplifiers set for a gain of 1000 and using low (35 Hz) and high (0.05 Hz) pass filters. The interbeat interval (IBI) was computed by Fast-Fourier Transform using the Mindware (Westerville, OH) HRV 2.16 biosignal processing system. This program computed the average normal IBI over each two minute period. To perform HRV analyses, the Mindware program identified the IBIs, detected physiologically improbable IBIs based on the overall IBI distribution using a validated algorithm (Bernston, Quigley, Jang, & Boysen, 1990), and detrended the data using a first order polynomial to remove the mean and any linear trends, cosine tapered the data and submitted it to Fast-Fourier Transformation, and took the natural log integral high frequency power (0.15-0.40 Hz). The resulting number was used as the baseline RSA.

Skin conductance data was also collected with Biopac TSD203 transducers filled with Biopac Skin Conductance Electrode Paste placed on the middle and fourth fingers of the non-dominant hand. Data was amplified using Biopac GSR100C amplifier with a gain of 10µΩ and a low pass filter of 10 Hz. Mindware’s EDA 2.1 computer program identified all electrodermal responses (EDRs), which is defined as a 0.05µS increase in skin conductance.
The film clips were shown digitally using Mindware’s Active Movie Player, which embeds the physiological record with a digital trigger at the beginning of the film. This trigger allows for the discrete analysis of data for the two minutes prior to the film and during the film presentation itself.

Results

Sample Characteristics

This study recruited 125 participants from a small, private, Mid-western university. Data from twelve participants were not included in analyses due to reported medical conditions which impact emotional and/or autonomic functioning. Of the remaining 113 participants, 94.7% identified themselves as not Hispanic (see Table 1). The majority reported their race as white (66.4%), followed by Asian (18.6%), black (6.2%), Pacific Islander (.9%), and other (8%), with women outnumbering men (63 versus 50). The average age for participants was 19.19 years with a standard deviation of 2.11 years.

A summary of the range, mean, and standard deviation for each of the questionnaires that participants were given can be seen in Table 2. Of note is the wide range of SAT scores present in this sample; thus, corrections for restrictions of range were not used.

Seventy participants were randomly assigned to the experimental group (those who received reappraisal training) and 43 were assigned to the control group. Of these 113 participants, only 86 had SAT scores reported to the University and, hence, only these data points were included in analyses incorporating the SAT variable. The order in which the two positive and two negative film clips were shown was counterbalanced.
across participants, with comparable numbers of people viewing each of the four possible combinations (30 people watched PN/PN, 29 watched PN/NP, 28 watched NP/NP, and 26 watched NP/PN).

Table 1. Demographic Information

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>hispanic</td>
<td>6</td>
<td>5.3</td>
</tr>
<tr>
<td>not hispanic</td>
<td>107</td>
<td>94.7</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>asian</td>
<td>21</td>
<td>18.6</td>
</tr>
<tr>
<td>pacific islander</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>black</td>
<td>7</td>
<td>6.2</td>
</tr>
<tr>
<td>white</td>
<td>75</td>
<td>66.4</td>
</tr>
<tr>
<td>other</td>
<td>9</td>
<td>8.0</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>50</td>
<td>44.2</td>
</tr>
<tr>
<td>female</td>
<td>63</td>
<td>55.8</td>
</tr>
</tbody>
</table>

Table 2. Self-report Questionnaires

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal</td>
<td>86</td>
<td>370</td>
<td>800</td>
<td>615.58</td>
<td>98.848</td>
</tr>
<tr>
<td>Math</td>
<td>86</td>
<td>360</td>
<td>800</td>
<td>646.98</td>
<td>92.088</td>
</tr>
<tr>
<td>SAT</td>
<td>86</td>
<td>750</td>
<td>1540</td>
<td>1262.56</td>
<td>165.332</td>
</tr>
<tr>
<td>ER0r</td>
<td>113</td>
<td>11</td>
<td>40</td>
<td>29.58</td>
<td>4.726</td>
</tr>
<tr>
<td>ER0s</td>
<td>113</td>
<td>1</td>
<td>25</td>
<td>13.69</td>
<td>4.462</td>
</tr>
<tr>
<td>BIS</td>
<td>113</td>
<td>7</td>
<td>22</td>
<td>12.65</td>
<td>3.206</td>
</tr>
<tr>
<td>SocDes</td>
<td>113</td>
<td>4</td>
<td>30</td>
<td>15.73</td>
<td>4.745</td>
</tr>
</tbody>
</table>

Manipulation Checks

A manipulation check was performed using analysis of variance to test the emotional content of the film clips. Each of the positive and negative clips were entered as independent variables and SAM valence acted as the dependent variable. A significant
main effect was found (F=236.96, p<.01). Specifically, post-hoc Least Significant Difference (LSD) tests revealed that the two negative clips induced significantly greater negative emotional response (i.e., lower SAM scores) (Negative Film 1; M = 2.44, SD = .68; Negative Film 2; M = 2.13, SD = .87) than did the two positive movies (i.e., higher SAM scores) (Positive Film 1; M = 4.29, SD = .61; Positive Film 2; M = 3.90, SD = .71). Moreover, by comparing each film to “neutral” responses (i.e. SAM score = 3), it was found that the two negative films both elicited significant negative emotional response and the two positive films each elicited significant positive emotional response, all ps < .05.

Alpha reliability was calculated for the two independent raters who coded participants’ videotaped facial expressions as they watched the four film clips (-100 = extreme negative facial affect; 0 = neutral; +100 = extreme positive facial affect). Because a high alpha reliability of 0.941 was found, the raters’ scores were averaged together and used in subsequent analyses. Using analysis of variance, each of the films were entered as the independent variable and facial expression as the dependent variable. A significant main effect was found (F=104.95, p<.01) and LSD tests showed that facial expressions were significantly more negative for the negative films (Negative 1 M= - .39, SD= 6.81; Negative 2 M= -8.12, SD= 15.44) and more positive for the positive films (Positive 1 M= 22.38, SD= 16.74; Positive 2 M= 9.84, SD= 13.007). Each film was significantly different from the other three in terms of facial expression (p<.001), though only the second positive film differed significantly from neutral (p<.05).

Table 3 summarizes the differences in reappraisal use, electrodermal response, and facial expression for each of the four film clips. Table 4 shows no difference in the
choice of regulation strategy between those who received reappraisal training and those who did not (p=.98). No difference in age (p=.55) or SAT score (p=.26) were found between the experimental and control group.

In addition to these manipulation checks, reappraisal reactivity (Time 2 reappraisal use minus Time 1 reappraisal use) was used as the criterion variable in several linear hierarchical multiple regressions. First, baseline RSA and condition (experimental versus control group) were examined. Baseline RSA and condition were entered in Block 1, were controlled for in Block 2, and the interaction between condition and RSA was entered in Block 2. Baseline RSA was significant (B=-10.51, p<.05), so that increased use of reappraisal after training was associated with lower RSA. Condition was not significant (p=.34) and the interaction between RSA and condition was not significant (p=.27). Second, social desirability and condition were entered as Block 1, controlled for in Block 2, and the interaction was again entered in Block 2. Neither condition (p=.46), social desirability (p=.20), nor the interaction (p=.55) were significant. Additional linear hierarchical multiple regressions were performed to look at the interaction between SAT score and reappraisal use to each of the four film clips. No significant interactions with SAT were found for the first positive film (p=.92), the first negative film (p=.70), the second positive film (p=.99), or the second negative film (p=.35).
Table 3. Differences in reappraisal, electrodermal responses [EDR], and facial expression across film clips.

<table>
<thead>
<tr>
<th>Film clip</th>
<th>Mean Reappraisal Use (Std. Error)</th>
<th>P value</th>
<th>Mean EDR (Std.Error)</th>
<th>P value</th>
<th>Mean Facial Expression (Std. Error)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive 1</td>
<td>7.89 (3.09)</td>
<td>.001*</td>
<td>7.88 (.530)</td>
<td>.32</td>
<td>22.38 (1.29)</td>
<td>.001*</td>
</tr>
<tr>
<td>Negative 1</td>
<td>20.61 (3.09)</td>
<td>.001*</td>
<td>3.86 (.527)</td>
<td>.001*</td>
<td>-0.39 (1.29)</td>
<td>.001*</td>
</tr>
<tr>
<td>Positive 2</td>
<td>57.31 (3.09)</td>
<td>.001*</td>
<td>8.51 (.527)</td>
<td>.57</td>
<td>9.84 (1.29)</td>
<td>.001*</td>
</tr>
<tr>
<td>Negative 2</td>
<td>69.22 (3.09)</td>
<td>.001*</td>
<td>8.76 (.527)</td>
<td>.49</td>
<td>-8.12 (1.29)</td>
<td>.001*</td>
</tr>
</tbody>
</table>

Table 4. Effect of reappraisal training on emotion regulation strategy use.

<table>
<thead>
<tr>
<th>Training</th>
<th>Positive Film</th>
<th>Negative Film</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Reappraisal</td>
<td>Mean Suppression</td>
</tr>
<tr>
<td>Reappraisal</td>
<td>57.00</td>
<td>37.43</td>
</tr>
<tr>
<td>Alternate</td>
<td>55.10</td>
<td>32.88</td>
</tr>
</tbody>
</table>

Hypothesis testing

**Hypothesis 1**: Participants with higher baseline RSA will show less facial expression to the negative clip, but not the positive clip, both before and after reappraisal training.

Four separate multiple regressions using all (N=113) of the data (i.e., including data collected from those in either the reappraisal- or alternate- training group) were performed to analyze the relationship between RSA and facial expression. In each case, baseline RSA was entered as the predictor variable and facial expression to each of the four film clips was entered as the criterion variable. None of these analyses produced statistically significant results, as can be seen in Table 5.
Table 5. Baseline RSA and facial expression.

<table>
<thead>
<tr>
<th>Film clip</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>0.02</td>
<td>.00</td>
<td>-0.26</td>
<td>0.82</td>
</tr>
<tr>
<td>Negative</td>
<td>0.07</td>
<td>.01</td>
<td>0.33</td>
<td>0.50</td>
</tr>
<tr>
<td>After training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>0.05</td>
<td>.00</td>
<td>0.44</td>
<td>0.64</td>
</tr>
<tr>
<td>Negative</td>
<td>0.07</td>
<td>.01</td>
<td>-0.83</td>
<td>0.46</td>
</tr>
</tbody>
</table>

**Hypothesis 2:** Participants with higher baseline RSA will be more likely to use reappraisal as an emotion regulation strategy after reappraisal training.

Two multiple regression equations were used to determine if a relationship exists between RSA and increased reappraisal use after instruction, with RSA used as the predictor variable in each regression. The criterion variables were the percent reappraisal use to the positive and negative film after training, and data from only the reappraisal training group were included in analyses (N=70). RSA was not related to reappraisal use to the negative film after training ($R^2=.00$, $p=.46$) or to the positive film after training ($R^2=.01$, $p=.38$).

However, it should be noted that higher baseline RSA was correlated with increased reappraisal use in response to the positive film before training ($R^2=.04$, unstandardized beta=3.59, $p<.05$) and total reappraisal use to the first two clips combined ($R^2=.05$, unstandardized beta=7.26, $p<.05$). Even though no relationship was found with either of the individual clips post-training, baseline RSA and reappraisal reactivity (post-training reappraisal use minus pre-training reappraisal use) were significantly related ($R^2=.05$, $B=-13.90$, $p<.05$). Though people with high RSA spontaneously used reappraisal more than people with low RSA to the first two film clips, people with low RSA saw greater gains in reappraisal use after reappraisal training. In Figure 1, people
with RSA greater than one standard deviation above the mean are described as ‘high RSA’ and people with RSA lower than one standard deviation below are described as ‘low RSA.’ From this graph, it appears that reappraisal training is most effective for people with low RSA.

Figure 1. Baseline RSA and reappraisal reactivity.

Hypothesis 3: Participants with higher scores on the social desirability scale will use more reappraisal in response to the negative film clip before and after reappraisal training. An interaction effect will occur after the training session; specifically, use of reappraisal will increase the most for participants high in social desirability.

Five separate multiple regressions were performed to test this hypothesis. Social desirability was the predictor variable in all regressions and only data from the reappraisal group were included in analyses (N=70). As seen in Table 6, social
desirability was only able to predict reappraisal use to the negative film before training. Specifically, people with higher social desirability scores were more likely to use reappraisal in response to the first negative film. In addition, no interaction effect was seen when MCSD score and reappraisal reactivity were examined (R²=.01, p=.54).

Table 6. Social desirability and use of reappraisal as a regulation strategy.

<table>
<thead>
<tr>
<th>Film Clip</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Training</td>
<td>Positive</td>
<td>.13</td>
<td>.02</td>
<td>-.73</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>.25</td>
<td>.06</td>
<td>1.95</td>
</tr>
<tr>
<td>After Training</td>
<td>Positive</td>
<td>.01</td>
<td>.00</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>.02</td>
<td>.00</td>
<td>.12</td>
</tr>
</tbody>
</table>

**Hypothesis 4:** In addition, participants with higher reappraisal scores on the ERQ will use reappraisal more than those with lower scores both before and after reappraisal training. An interaction effect will occur after the training session such that persons with high scores will be associated with the greatest increase in reappraisal use.

Using data from the reappraisal training group (N=70), the reappraisal sub-score of the ERQ was used as the predictor variable in each regression and reappraisal use was the criterion variable. Results are summarized in Table 7. Please note that higher ERQ scores were associated with greater reappraisal use to the positive film only after reappraisal training.

Moreover, using data from both the reappraisal and alternate-training groups (N=113), support for an interaction effect was found, with higher ERQ scores being associated with increases of reappraisal use among those in the reappraisal training group (R²=.12, p<.01) but not the alternate training group (R²=.01, p=.75).
Table 7. ERQ and reappraisal use among people in the reappraisal training condition.

<table>
<thead>
<tr>
<th>Film Clip</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>.10</td>
<td>.01</td>
<td>.56</td>
<td>.43</td>
</tr>
<tr>
<td>Negative</td>
<td>.20</td>
<td>.04</td>
<td>1.52</td>
<td>.10</td>
</tr>
<tr>
<td>After Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>.30</td>
<td>.09</td>
<td>2.25</td>
<td>.01*</td>
</tr>
<tr>
<td>Negative</td>
<td>.09</td>
<td>.01</td>
<td>-.48</td>
<td>.46</td>
</tr>
</tbody>
</table>

Hypothesis 5: Participants with higher BIS scores will have greater levels of self-reported negative emotion to the negative films both before and after reappraisal training.

Using data from all participants (N=113), multiple regression was used to analyze this hypothesis, with BIS score entered as the predictor variable with self reported valence and arousal on the SAM for each of the four film clips. As seen in Table 8, participants with higher BIS scores experienced significantly less arousal to the negative film before training, and significantly increased negative affect to the negative film after training. A trend was seen between high BIS score and increased arousal after training, such that higher BIS scores predicted increased arousal (p=.07).

Table 8. Among all participants, behavioral inhibition and affect to negative films.

<table>
<thead>
<tr>
<th>Negative Film</th>
<th>SAM</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before training</td>
<td>Valence</td>
<td>.15</td>
<td>.02</td>
<td>-.03</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>Arousal</td>
<td>.23</td>
<td>.05</td>
<td>-.07</td>
<td>.01*</td>
</tr>
<tr>
<td>After training</td>
<td>Valence</td>
<td>.27</td>
<td>.07</td>
<td>.07</td>
<td>.01*</td>
</tr>
<tr>
<td></td>
<td>Arousal</td>
<td>.17</td>
<td>.03</td>
<td>.07</td>
<td>.07</td>
</tr>
</tbody>
</table>
Hypothesis 6: Persons with higher BIS scores will exhibit greater sympathetic activation (as measured by electrodermal response) to the negative film both before and after reappraisal training. This effect will be mediated by self-reported emotion.

Using data from all participants (N=113), multiple regressions were again used to test the relationship between BIS and sympathetic activation. BIS score was entered as the predictor variable with electrodermal response to all four film clips used as criterion variables. No significant relationships were found between BIS score and sympathetic activation (Table 9).

Table 9. BIS and electrodermal responses to film clips, for all participants.

<table>
<thead>
<tr>
<th>Negative Film Clip</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Training</td>
<td>.02</td>
<td>.00</td>
<td>.02</td>
<td>.83</td>
</tr>
<tr>
<td>After Training</td>
<td>.15</td>
<td>.02</td>
<td>-.30</td>
<td>.12</td>
</tr>
</tbody>
</table>

Hypothesis 7: Participants with higher BAS scores will have greater levels of self-reported positive emotion to the positive films both before and after reappraisal training.

Multiple regression was used to analyze this hypothesis, with total BAS score entered as the predictor variable with self reported valence and arousal on the SAM for each of the four film clips. No significant relationships were found between BAS and self-reported valence or arousal to the positive films (Table 10), using data from all participants (N=113). Three BAS subscales (drive, fun seeking, and reward responsiveness) were also tested; no significant relationships were found.
Table 10. Behavioral activation and self-reported affect to positive films.

<table>
<thead>
<tr>
<th>Negative Film</th>
<th>SAM</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before training</td>
<td>Valence</td>
<td>.09</td>
<td>.01</td>
<td>.78</td>
<td>.36</td>
</tr>
<tr>
<td></td>
<td>Arousal</td>
<td>.01</td>
<td>.00</td>
<td>.04</td>
<td>.94</td>
</tr>
<tr>
<td>After training</td>
<td>Valence</td>
<td>.18</td>
<td>.03</td>
<td>1.37</td>
<td>.06</td>
</tr>
<tr>
<td></td>
<td>Arousal</td>
<td>.14</td>
<td>.02</td>
<td>.84</td>
<td>.13</td>
</tr>
</tbody>
</table>

**Hypothesis 8:** Persons with higher BAS scores will exhibit greater sympathetic activation (as measured by electrodermal response) to the positive film than to the negative film both before and after reappraisal training.

Multiple regressions were used to test the relationship between BAS and sympathetic activation. Total BAS score was entered as the predictor variable with electrodermal response to all four film clips used as criterion variables. No significant relationships were found. The three BAS subscales were again entered as predictor variables and significant results were seen only for the drive subscale. As seen in Table 11, high BAS drive scores were significantly associated with more electrodermal responses to the positive films, both before and after training, using data from all participants (N=113).

Table 11. Behavior activation and electrodermal responses to film clips.

<table>
<thead>
<tr>
<th>Film Clip</th>
<th>R</th>
<th>R²</th>
<th>Unstandardized Beta</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Training</td>
<td>Positive</td>
<td>.20</td>
<td>.04</td>
<td>.43</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>.17</td>
<td>.03</td>
<td>.23</td>
</tr>
<tr>
<td>After Training</td>
<td>Positive</td>
<td>.21</td>
<td>.04</td>
<td>.47</td>
</tr>
<tr>
<td></td>
<td>Negative</td>
<td>.04</td>
<td>.01</td>
<td>.11</td>
</tr>
</tbody>
</table>
Hypothesis 9: There will be a positive correlation between SAT score and the successful use of reappraisal to both the positive and negative film clips following the training session.

Four multiple regression equations were used to test this hypothesis, with SAT score entered as the predictor variable for each regression and reappraisal use as the criterion variable. SAT score was not related to reappraisal use to the positive film \( (R^2=.01, p=.82) \) or the negative film \( (R^2=.01, p=.53) \) using data from the reappraisal training group \( (N=70) \). SAT score was also not related to reappraisal reactivity (post-training reappraisal use minus pre-training reappraisal use), so no interaction effect was present \( (R^2=.01, p=.48) \).

In addition to hypothesis testing, several exploratory analyses were additionally conducted. Men reported using significantly more suppression on the ERQ than women \( (p<0.01) \), though this finding was not supported by their actual behavior while watching the four film clips \( \text{Positive 1, } p=.87, \text{ Negative 1, } p=.10, \text{ Positive 2, } p=.37, \text{ Negative 2, } p=.12 \). Men also reported significantly higher behavioral inhibition on the BIS/BAS scale than women \( (p<0.001) \). In addition, BIS score was related to baseline levels of self-reported affect. Higher BIS was correlated with a more negative \( (R^2=.02, p<.05) \) and less aroused baseline \( (R^2=.05, p<.01) \). Women expressed significantly more negative facial expression to the second negative film depicting an animal slaughterhouse \( (p<0.001) \).

While SAT score did not appear to be linked to reappraisal use, higher scores on the math subtest were significantly correlated with both the reappraisal \( (R^2=.05, p=.05) \) and suppression \( (R^2=.10, p=.01) \) subscales of the ERQ. In addition, higher math subtest
scores were correlated with the selection of suppression as a regulation strategy to the post-training negative film ($R^2=.05$, $p=.05$).

Discussion

Summary of findings

Evidence was found to support several of the hypotheses generated by this study. First, participants (before any training) with high baseline RSA spontaneously used reappraisal more than those with lower baseline RSA in response to both negative and positive emotional stimuli. High scores on the reappraisal subscale of the ERQ were positively correlated with using reappraisal as an emotion regulation strategy to the positive film after reappraisal training. High ERQ scores were also linked to increased reappraisal use after training compared to before training. Participants who reported high behavioral inhibition reported feeling greater negative emotion in response to the negative clip after training. People with high scores on the BIS subscale reported less self-reported arousal to the negative film before training and more self-reported negative emotion to the negative film after training than people with low behavioral inhibition. Yet, those with high BIS did not show increased sympathetic arousal, as measured by skin conductance. In regards to behavioral activation, people with high BAS scores did have greater sympathetic arousal to the positive film, but no relationship to self-reported valence or arousal to the positive films were found.

While some hypotheses were supported, some unexpected findings emerged from this research as well. RSA did not predict facial expression to either the positive or the negative films clips and people with higher RSA levels did not use more reappraisal after
reappraisal training. On the contrary, people with high RSA spontaneously used more reappraisal before training and people with lower RSA made greater advances in reappraisal use after training than those with high RSA. No interaction was found between social desirability and reappraisal use, and social desirability was only correlated with increased reappraisal to the negative film before training. In this study, SAT scores did not predict actual reappraisal use. Surprisingly, the math subtest of the SAT was significantly correlated with the suppression subscale of the ERQ. In addition, higher math subtest scores were correlated with the selection of suppression as a regulation strategy to the post-training negative film.

Elaboration

Several interesting findings surfaced relating to RSA. First, participants (before any training) with high baseline RSA spontaneously used reappraisal more than those with low baseline RSA in response to both negative and positive emotional stimuli. This indicates that people with high RSA appear to be more intrinsically motivated to regulate their emotions via reappraisal. As previously discussed, high RSA has been linked with a variety of positive outcomes, such as self regulatory ability, adaptability, attentional control (Thayer & Lane, 2000). It appears that the association between RSA and regulatory ability can be expanded to include a person’s emotion regulation ability and their inclinations towards using a particular regulation strategy. Second, it was hypothesized that people with high RSA would benefit the most from reappraisal training; that an interaction effect would occur so that high RSA people would increase their reappraisal use more than low RSA people from time 1 (before training) to time 2 (after training). In fact, almost the exact opposite of what was expected actually
occurred. High RSA people did not use more reappraisal after reappraisal training; they used non-significantly less reappraisal than people with lower RSA. An interaction effect was indeed found, but it was people with lower RSA who made the greatest advances in reappraisal use after training. While these results were unexpected, it is helpful to know that the people who are in greatest need of emotion regulation ability are the people who will benefit the most from said training. This may be of particular use to clinical populations with dysregulation troubles where reappraisal training will improve social functioning.

A notably absent finding was the relationship between baseline RSA and facial expression, that is, RSA did not predict facial expression to either positive or negative stimuli. Numerous studies have reported a relationship between RSA and negative facial expressions in the past (Demaree, Pu, Robinson, Schmeichel, & Everhart, 2006). The main difference between these previous experiments and the current study is the use of paced breathing to control respiration rate.

Grossman and Taylor (2007) state that slow deep breathing produces more accurate RSA measurement (as opposed to rapid shallow breathing) and that paced breathing may better provide a person’s true RSA. They perceive baseline RSA as an indication of potential backup energy which is readily available for tasks such as speaking, expressing emotions, working on difficult mental tasks, or modulating facial expressions (Grossman & Taylor, 2007). Muscle control is necessary to manage facial expressions, which requires energy. They propose that RSA is directly linked to energy efficiency and behavior by matching these demands with metabolism (Grossman & Taylor, 2007). Grossman and Taylor (2007) state that several factors in addition to
respiratory rate can confound RSA’s estimation of vagal tone and beta-adrenergic tone (unrelated to parasympathetic activity). Viewing paced breathing as a more precise measure of RSA, previous correlations between RSA and facial control must have been based on sub-optimal measurements. Because this experiment did not involve gross physical activity, participants who were taking medications or had been diagnosed with clinical disorders were not included in analyses, and respiration rate was controlled for by paced breathing, it can be assumed that RSA was calculated with greater precision in the study. Yet, because the relationship between RSA and facial expression has been well documented on multiple occasions, it is possible that some third factor is present when respiration rate is not controlled for and that future research will be able to account for this phenomenon.

Regarding the Emotion Regulation Questionnaire, high scores on the reappraisal subscale were associated with reappraisal use to the positive film only after reappraisal training. High ERQ scores were also linked to increased reappraisal use after training compared to before training. From this, it seems the ERQ does not predict natural emotion regulation, but instead indicates how receptive a person is to specific reappraisal training.

Behavioral inhibition was linked to both self-reported arousal level and negative emotion, but not to sympathetic arousal. People with higher BIS scores reported less arousal to the negative film before training and more negative emotion to the negative film after training. Yet, those with high BIS did not show increased sympathetic arousal, as measured by skin conductance. With regard to BAS, behavioral activation was not linked to either self-reported arousal or negative emotion, but was associated with
sympathetic arousal. Specifically, people with high BAS scores had greater sympathetic arousal to the positive film, but no relationship to self-reported valence or arousal to the positive films was found. Combined, these results partially support the idea that BIS is related to negative emotion and BAS is related to positive emotion, but there may be disparities in which these relationships exist. It may be that behavioral activation is more unconscious than behavioral inhibition. That is, inhibition is a conscious choice and activation is an involuntary reaction. This would explain why BAS relates to the autonomic nervous system while BIS relates to self-reported (and thus conscious) emotional processing.

In this study, social desirability was utilized to see if a person who wants to present themselves in a positive light to others is likely to use reappraisal as an emotion regulation strategy to achieve this goal. It was hypothesized that people with high social desirability would use more reappraisal naturally and be more receptive to reappraisal training. No interaction effect was found between social desirability and reappraisal use due to training, but social desirability was correlated with increased reappraisal to the negative film before training. This indicates that people who feel the need to present themselves as socially adept have already learned the benefits of reappraisal in negatively charged emotional situations. Reappraisal training may not have increased reappraisal use for people with high social desirability because of ceiling effects, meaning that reappraisal use could not increase for this group because it was already quite high.

Finally, SAT scores did not predict actual reappraisal use. It is surprising that such a cognitively oriented strategy like reappraisal was not at all related to this particular measure of cognitive ability. An unforeseen relationship between math ability and the
suppression subscale of the ERQ was found, such that higher math scores were related to reports of greater suppression use on the ERQ. In addition, higher math subtest scores were correlated with the selection of suppression as a regulation strategy to the post-training negative film. Taken together, this suggests that math ability is associated with the habitual use of an inferior emotion regulation strategy. This finding is surprising considering the negative outcomes of chronic suppression that were discussed earlier, including memory impairment, lack of closeness in relationships, and cardiovascular disorders (Richards & Gross, 2000). It is possible that overall intelligence, or $g$, is not related to emotion regulation ability, but that certain like math ability, are. This idea is supported by Schmeichel, Volokhov, and Demaree (submitted), in which high working memory was associated with successful reappraisal use. Further research may provide insight into the nature of the relationship between specific emotion regulation strategies and various measures of intelligence.

Implications

Both theoretical and practical implications have emerged from this study. First, the results from correcting RSA with paced breathing supports the argument that 1) RSA is influenced by respiration rate and 2) correcting for respiration rate dissociates RSA from the ability to control facial expressions to negative emotional stimuli. This finding will inform future experimental design. The findings garnered from this experiment may impact such diverse fields as clinical psychology, industry, and politics. First and foremost, the finding that reappraisal training can have an immediate effect on the behavior of normal participants suggests that people who have difficulty regulating their
emotions due to a mood disorder, such as depression or anxiety, may also receive some benefit from reappraisal training. Identifying the people who will be most receptive to this type of training will increase the chances of success. Regardless of gender, social desirability, or intelligence, people who currently use little or no reappraisal will benefit the most. The practical implications of this research on industry and politics lies in the need for business leaders and politician to constantly regulate themselves in varied and sometimes stressful social situations. Reappraisal training could not only benefit these people, but any person who regularly participates in social activities and feels the need to control their emotions.

Limitations

This study has several limitations. For instance, the sample size may have been insufficient to reveal the presence of smaller effect sizes or these findings may only characterize the nature of this particular sample population, that is, college students attending a selective university. This study may also have been limited by the reappraisal training method used; both the intensity and the period of time training occurred could have been greater and thus had a more pronounced effect on participant behavior. Also, by immediately testing the effects of reappraisal training, it is unknown whether the training itself conveyed any lasting outcomes to the participants. Finally, personal preference for humor or previous exposure to the types of negative films presented may have influenced participants’ felt emotion and, thus, the amount of emotion regulation needed.
Future directions

The findings from this study will provide the impetus for further experimentation. First, the method of reappraisal training could be greatly expanded upon in terms of length and intensity. Training could be spread out over several sessions to maximize learning. Different sample populations could also add valuable data. Testing different age groups, socioeconomic groups, and clinical populations would broaden the scope of this research and add to its generalizability. Second, paced breathing and its relationship to RSA and facial expression is an area that should be further investigated. Gaining a deeper understanding of this relationship will assist researchers in understanding the role of respiration rate in behavioral regulation. Finally, future studies may concentrate on the relationship suggested by this work between math ability and the selection of suppression as an emotion regulation strategy.
Appendix A

Demographic / Medical History Questionnaire

My age is: ________________ years

I am (circle one): Male Female

Ethnicity (circle one): Hispanic or Latino

NOT Hispanic or Latino

Racial Background (circle one):

American Indian/Alaska Native

Asian

Native Hawaiian or Other Pacific Islander

Black or African American

White

Other ____________________________

Medical History

Have you ever experienced or been diagnosed with any of the following, or are you experiencing any of the following at present: (Please circle the appropriate response and explain “Yes” answers below).

1. Cardiovascular disease (e.g., hypertension).............. Yes No
2. Psychiatric illness (e.g., depression, anxiety)............ Yes No
3. Are you currently taking any prescription medications/drugs for psychiatric or cardiovascular reasons................................................................. Yes No
4. Do you experience fear or anxiety when left in a small room alone?................................................................. Yes No

Please explain “Yes” responses:

__________________________________________________________________________

__________________________________________________________________________
Appendix B

Consent Form for SAT Score Release

In order to complete the analysis of this research, the experimenters need to access your SAT scores from the Office of Admissions. This information will be kept confidential and in a secure location. Only the experimenters will have access to these data in any form that could be connected to you. If you do consent to the release of your SAT score, please read and sign the statement below. If you do not give consent for the release of your SAT you will still receive credit for participation.

I, _______________________, give my permission for a portion of my application for admission to Case Western Reserve University to be made available to Rachael Volokhov and Dr. Heath Demaree in the Department of Psychology for the purposes of conducting research. I understand that in giving this consent, I am waiving my right of confidentiality under the Family Educational Rights and Privacy Act in this information for the limited purpose of this study. Specifically, I consent to the University releasing the results of my SAT testing made available to them during the application process to Rachael Volokhov. I understand that this data will be maintained in a safe and secure manner by Rachael Volokhov.

Signature of Student: _________________________ Date: ________________

Year of Entrance at CWRU: ______________________

Social Security #: _________________________
Appendix C

**ERQ**

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:

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>strongly disagree</td>
</tr>
<tr>
<td>2</td>
<td>neutral</td>
</tr>
<tr>
<td>3</td>
<td>strongly agree</td>
</tr>
</tbody>
</table>

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.
Appendix D

MCSD

Listed below are a number of statements concerning personal attitudes and traits. Read each item and decide whether the statement is true or false as it pertains to you personally.

1. Before voting, I thoroughly investigate the qualification of all the candidate.____
2. I never hesitate to go out of my way to help someone in trouble.____
3. It is sometimes hard for me to go on with my work if I am not encouraged.____
4. I have never intensely disliked anyone.____
5. On occasion I have had doubts about my ability to succeed in life.____
6. I sometimes feel resentful when I don’t get my way.____
7. I am always careful about my manner of dress.____
8. My table manners at home are as good as when I eat out in a restaurant.____
9. If I could get into a movie without paying and be sure I was not seen I would probably do it.____
10. On a few occasions, I have given up doing something because I thought too little of my ability.____
11. I like to gossip at times.____
12. There have been times when I felt like rebelling against people in authority even though I knew they were right.____
13. No matter who I’m talking to, I’m always a good listener.____
14. I can remember “playing sick” to get out of something.____
15. There have been occasions when I took advantage of someone.____
16. I’m always willing to admit it when I make a mistake.____
17. I always try to practice what I preach.____
18. I don’t find it particularly difficult to get along with loud mouthed, obnoxious people.____
19. I sometimes try to get even rather than forgive and forget.____
20. When I don’t know something I don’t at all mind admitting it.____
21. I am always courteous, even to people who are disagreeable.____
22. At times, I have really insisted on having things my own way.____
23. There have been occasions when I felt like smashing things.____
24. I would never think of letting someone else be punished for my wrong-doings.____
25. I never resent being asked to return a favor.____
26. I have never been irked when people expressed ideas very different from my own.____
27. I never make a long trip without checking the safety of my car.____
28. There have been times when I was quite jealous of the good fortune of others.____
29. I have almost never felt the urge to tell someone off.____
30. I am sometimes irritated by people who ask favors of me.____
31. I have never felt that I was punished without cause.____
32. I sometimes think when people have a misfortune they only got what they deserved.____
33. I have never deliberately said something that hurt someone’s feelings.____
Appendix E

**BIS/BAS**

Directions: Below is a series of statements that people might use to describe how they generally feel. Read each statement and decide whether it reflects your thoughts, with 1=strongly agree and 4=strongly disagree.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>If I think something unpleasant is going to happen I usually get pretty “worked up”</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I worry about making mistakes</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Criticism or scolding hurts me quite a bit</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I feel pretty worried or upset when I think I know someone is angry at me</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Even if something bad is about to happen to me, I rarely experience fear or nervousness</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I feel worried when I think I have done poorly at something</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I have very few fears compared to my friends</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>When I get something I want, I feel excited and energized</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>When I’m doing well at something, I love to keep at it</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>When good things happen to me, it affects me strongly</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>It would excite me to win a contest</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>When I see an opportunity for something I like, I get excited right away</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>When I want something, I usually go all-out to get it</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>I go out of my way to get things I want</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>If I see a chance to get something I want, I move on it right away</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>When I go after something I use a “no holds barred” approach</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>I will often do things for no other reason than that they might be fun</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>I crave excitement and new sensations</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>I’m always willing to try something new if I think it will be fun</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>I often act on the spur of the moment</td>
<td></td>
</tr>
</tbody>
</table>
Appendix F

Please place an X over the figure that best describes how you feel right now. For example, if you feel completely happy or contented, you could indicate that by placing an X on the figure at the left. On the other hand, if you feel completely unhappy or unsatisfied, you could indicate that by placing an X on the figure at the right. The figures also allow you to describe intermediate feelings of pleasure by placing an X over any of the other pictures.

Again, please place an X over the figure that best describes how you feel right now. For example, if you feel completely stimulated, excited, or aroused, you could indicate that by placing an X on the figure at the left. On the other hand, if you feel completely relaxed, calm, or unaroused, you could indicate that by placing an X on the figure at the right. The figures also allow you to describe intermediate feelings of arousal by placing an X over any of the other pictures.
Appendix G

Post-Film Questionnaire

**Negative Film**

1. Did you try to control your emotions during the film clip? (Circle one)  
   Y  N

   If you answered YES, please continue to question 2.

2. What strategies did you use to accomplish this? (Check all that apply)  How much did you use each strategy (total should add to 100) and how effective (on a scale of 1-5) were they?

   Strategy                                                                 % used   Effectiveness
   ___ I thought of something completely different
   ___ I concentrated on my face muscles
   ___ I tried to think of the negative things in a different light
   ___ I clenched my jaw
   ___ I focused on my breathing
   ___ I pretended it wasn’t real
   ___ I tried to take a scientific approach
   ___ I thought about the technical aspects of the film (ex: camera angle)
   ___ Other: ______________________________________

**Positive Film**

1. Did you try to control your emotions during the film clip? (Circle one)  
   Y  N

   If you answered YES, please continue to question 2.

2. What strategies did you use to accomplish this? (Check all that apply)  How much did you use each strategy (total should add to 100) and how effective (on a scale of 1-4) were they?

   Strategy                                                                 % used   Effectiveness
   ___ I thought of something completely different
   ___ I concentrated on my face muscles
   ___ I told myself it wasn’t that funny
   ___ I clenched my jaw
   ___ I thought about the technical aspects of the film (ex: camera angle)
   ___ Other: ______________________________________
Appendix H

Initial Instructions to Participants

“First, we will attach some electrodes to you. One will be under your right collarbone, one will be on your left lowest rib, and two will be on your fingers. If you like, you may place them yourself or I can put them on for you; whichever way you prefer. After that, you will relax for several minutes to acclimate to your surroundings. The instructions ‘Please sit still and relax’ will appear on the computer screen in front of you. These instructions will last for about two minutes. Try not to move too much because it will affect the physiological data. Then you will watch two short film clips. After each clip you will be asked several questions. Following a short break, you will watch two more film clips and complete a final questionnaire. If at any time you would like to terminate the experiment, please feel free to say so. Do you have any questions?”

Debriefing

“The experiment is now over. Thank you for participating. I would like to discuss the purpose of this experiment. This experiment was designed to see how people naturally control their emotions to positive and negative stimuli, and if this can be altered by teaching people about different strategies. This experiment also questions if emotion regulation is influenced by physical and cognitive traits. I ask that you not discuss the specifics of this experiment with other students, as it may change the way they would normally act. Thank you again for participating.”
Appendix I

Reappraisal Training

Practically everyone tries to control their emotions when they’re in certain situations. For instance, you may want to laugh at a joke you just remembered, but you can’t because your friend is in the middle of telling you a sad story. Or, you may feel really upset about a grade on a test, but don’t want to embarrass yourself in the middle of class. A lot of it depends on the situation that you’re in and what is considered appropriate behavior for it. There are two common strategies that psychologists have been researching when it comes to regulating your emotions; these are known as suppression and reappraisal.

Suppression happens once you are already feeling an emotion and you’re just trying to control your facial expression, posture, and gestures. You might be concentrating very hard not to frown or wrinkle your nose to something you dislike, or you may press your lips together to keep from smiling at something amusing. Suppression is a physical behavior strategy.

In contrast to this, reappraisal is a cognitive strategy. When you reappraise something, you’re rethinking it in a different way, or trying to alter your thoughts to make something negative seem less upsetting. For instance, you may be watching a disgusting surgery on TV, but if you try to keep your thoughts unemotional and objective, it might not be so disgusting after all. You could concentrate on the technical skill of the doctor, or the changing camera angles, or even distract your thoughts for a moment or two until the worst of it was over. Reappraisal is thinking about a situation in a different way that makes it less emotional to you. Some researchers have suggested that
reappraisal is better than suppression because it may be more successful at reducing how much emotion you feel and that it’s less stressful on your body’s nervous system.

Just to make sure you understand the difference between suppression and reappraisal, I’m going to tell you about a situation and you’ll respond with the strategy the person used.

1) Ben has to present a paper in front of his class, but he has really bad stage fright. To fight this feeling, he imagines the class in their underwear.

2) Hailey is watching a movie with her friends and the dog gets hit on the road. Her dog died last month and she wants to cry, but can’t in front of her friends, so she covers her mouth with her hand and blinks a lot.

3) Erin is at a funeral for a distant relative and sees a clumsy cousin trip and fall to the floor. Erin wants to burst out laughing, but controls it by shifting attention to the sad music that’s playing and thinking how sad it is.
Appendix J

Alternate Training

The formal recognition of individual differences in mental ability as a subject for study in its own right arose as an outgrowth of the idea of evolution in the mid-nineteenth century. For the first time in history, animals’ behavioral capacities and humans’ mental ability were recognized as a product of the evolutionary process, just as the physical systems of organisms. Darwin’s theory of natural selection as the mechanism of evolution implied that organisms’ behavioral capacities, along with their anatomy and physiology, evolved as adaptations to particular environments. In Darwin’s theory, hereditary variation is a necessary condition for the working of natural selection. From this insight, Herbert Spencer, the early philosopher of evolution, interpreted individual differences as intrinsic to the human condition. He further introduced the notion that human intelligence evolved as a unitary attribute.

Individual differences in mental qualities, however, did not become a subject for empirical study in its own right until the latter half of the nineteenth century, with the pioneer efforts of Sir Francis Galton, who is generally regarded as the father of differential psychology (the study of individual and group differences in human traits, which includes behavioral genetics). Galton introduced the idea of objective measurement of human capacities, devised tests to measure simply sensory and motor functions, and invented many of the statistical concepts and methods still used in the study of individual differences. He was the first to apply empirical methods to studying the inheritance of mental ability (Jensen, 1998).
References


