Bachelor Degree Project

UNIVERSITY OF SKÖVDE

RETHINKING THE ROLE OF ANXIETY

Using cognitive reappraisal in the classroom

Bachelor Degree Project in Cognitive Neuroscience
Basic level 22.5 ECTS
Autumn term 2019

Mona Montasser

Supervisor: Joel Parthemore
Examiner: Pilleriin Sikka

Abstract

This thesis provides an overview of the literature both in the field of academic anxiety and emotion regulation. The two research fields have proceeded independently in the literature at least until recently and the thesis highlights their integration. The thesis aims to answer: what happens in the brain during cognitive reappraisal and how can we use cognitive reappraisal as a strategy for dealing with academic anxiety. Brain-imaging studies show that cognitive reappraisal (an emotion regulation strategy) involves many different higher-order cognitive processes, such as emotion processing, manipulation of appraisals in working memory, inhibiting the old and selecting new appraisals. Different regions of the prefrontal cortex are believed to support these functions, moreover, the prefrontal cortex modulates amygdala activity and decreases negative emotions. Previous research in the lab and in the classroom suggests that cognitive reappraisal *might* be a strategy for dealing with academic anxiety. The arousal reappraisal intervention encourages students to reinterpret their increased arousal as beneficial to their performance. Only a small number of studies have tested the intervention in academic contexts, however the results are promising, e.g. students improved exam performance. The goal is to teach students that it is possible to perform well regardless of one's anxiety. The findings presented in this thesis provide an initial glimpse into the fruitful integration of these two research fields.

Keywords: academic anxiety, performance, cognitive reappraisal, prefrontal cortex, arousal reappraisal intervention

Table of Contents

1. Introduction

As children become older and proceed through the educational system, the number of exams increases and so does the pressure to perform well, with pressure from parents, teachers and the students themselves (Cassady, 2010; Maloney & Beilock, 2012). Studies show that levels of self-reported anxiety increase in frequency with age (Mazzone et al., 2007). A longitudinal study found that highly anxious First Graders had even higher scores on anxiety and depression in the Eighth Grade. Their symptoms of anxiety were associated with long-term academic, social and psychological difficulties (Grover, Ginsburg, & Ialongo, 2007). 25-40% of students experience test anxiety and many seem to adopt a view of hopelessness towards future testing situations (Cassady, 2010). The most studied and commonly experienced types of academic anxiety are test and math anxiety (Maloney, Sattizahn, & Beilock, 2014). A student's academic performance is very much affected by their anxiety, studies show that performance on a math test varies as a function of the individual's math anxiety (Ashcraft & Krause, 2007). Data from Program for International Student Assessment (PISA) shows that this is true for math performance both within and across countries worldwide (Foley et al., 2017). Students with high math anxiety score 34 points lower compared to students with no math anxiety, it is equivalent to one full school year (OECD, 2013). Lyons and Beilock (2012) found in an fMRI study that when highly math anxious individuals are anticipating an upcoming math task, regions in the brain associated with actual pain are activated. This could explain why highly math anxious students try to avoid math, potentially creating a vicious cycle. By avoiding math classes the student becomes less competent, performs worse, resulting in more math anxiety (Ashcraft, 2002). Research shows that students with high levels of test or math anxiety risk falling behind in school (Maloney et al., 2014) and in the worst case may lead to academic failure (Mazzone et al., 2007). Another problematic aspect of academic anxiety is its capacity to be

generalized; severe test anxiety can over time be generalized to many other evaluative situations adding to more underachievement. Math anxiety can also be generalized to physics and chemistry because mathematics is involved both subjects (Huberty, 2009). Poor performance may have nothing to do with the person lacking motivation, effort or even skill, it can simply be because of the anxiety (Ashcraft, 2002; Beilock, Schaeffer, & Rozek, 2017).

Attentional control theory explains how anxiety impacts performance. Anxiety creates a dual-task situation where thoughts of worry interfere with the attention needed for performing the actual task. When performing a task, especially when it is cognitively demanding, one's full attention is needed to give a good performance. Due to the impaired attentional control, caused by anxiety, the inhibition and shifting functions are not working properly making it more difficult to inhibit task-irrelevant stimuli (such as worry) and to shift attention towards task-relevant stimuli (the task at hand) (Eysenck, Derakshan, Santos, & Calvo, 2007).

The life of a student involves many test-taking situations, and math is a subject that is present and essential in most educational systems. It is therefore important to know how to deal with the anxiety. Educators are faced with the challenge of how to best prepare students for coping with their anxiety so that their performance actually can reflect their true abilities. Some studies show that writing down anxious thoughts before entering an exam can decrease anxiety and result in better performance. The act of writing down is believed to make the working memory resources more available thus eliminating the tug of war between the worry and the task at hand (Klein & Boals, 2001; Ramirez & Beliock, 2011). More researchers are suggesting that students need to be taught effective strategies that can help them self-regulate their emotional stress and gain emotional control (Bradley et al., 2010; Foley et al., 2017).

One such strategy has been put forward by research in the field of emotion regulation. Emotion regulation is the processes that influence which emotions we feel, when and how they are experienced and expressed (Gross, 1998b). In the generation of emotions appraisals are highly influential, appraisals are interpretations we make about an emotional stimulus. Appraisals shape our emotions, in such a strong way that two people can enter the same situation but have two completely different emotional experiences (Siemer, Mauss, & Gross, 2007). Cognitive reappraisal is the *rei*nterpretation of an emotional stimulus and is central in cognitive behavioral therapy, effectively treating mood and anxiety disorders as well as more general stress (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012).

In high-pressure situations many students, by default, are interpreting their increased arousal as a sign of anxiety (Johns, Inzlicht, & Schmader, 2008). Students are advised to calm down when feeling anxious, that is however difficult to do. The advice has also been found ineffective in decreasing the body's physiological response. It is instead suggested to harness the increased arousal (Brooks, 2014). A reappraisal intervention called arousal reappraisal has shown promising result in breaking the link between anxiety and poor performance (e.g. Jamieson, Peters, Greenwood, & Altose, 2016). The purpose is to reinterpret the increased arousal as beneficial (instead of debilitating) to performance, acknowledging the positive aspects; e.g. increased heart rate means that more oxygen is delivered to the brain which aids performance.

Cognitive reappraisal is a form of cognitive control ad activates many different higher-order cognitive control processes. Brain-imaging studies show that reappraisal activates different regions in the prefrontal cortex (inc dmPFC, dlPFC and vlPFC) and decrease amygdala activity (e.g. Ochsner, Silvers, & Buhle, 2012).

This thesis has two aims, first to review the literature of what happens in the brain during cognitive reappraisal and second review how we can use cognitive reappraisal as

a strategy for dealing with academic anxiety. Because of the large number of studies in both fields (the emotion regulation, and academic anxiety literature) restrictions had to be made, not diving too deep in any of the fields. The thesis only focuses on: test and math anxiety (although they are not the only types of academic anxiety), in terms of academic anxiety gender and cultural differences were not included as well as the extended process model of emotion regulation. Moreover, due to the large amount of brain research, the thesis is only including: functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) studies. This means that electroencephalography (EEG) and event-related potentials (ERP) studies were not included in the thesis.

In the search for articles, I used the databases Google Scholar, Scoups and Web of Science, using keywords such as “anxiety” + “academic performance”, “test anxiety”, “cognitive reappraisal., “cognitive reappraisal” +” brain” and “emotion regulation” +” classroom”.

The thesis is divided into four background sections, starting with explaining the terms stress and arousal, thus demonstrating how they differ from anxiety. The second part describes academic anxiety and how it affects performance negatively. The third part presents the emotion regulation literature with focus on cognitive reappraisal describing the important models and brain areas involved in performing reappraisal. The final part demonstrates the research integrating emotion regulation with academic anxiety, highlighting the biopsychosocial model of challenge and threat, and suggests how we can use cognitive reappraisal in the battle against academic anxiety. The thesis ends with a discussion, focusing on the aims and thoroughly discusses specific aspects that are important to consider in terms of the arousal reappraisal intervention, such as how well the results can be generalized as its long-term effect. Practical implications will be given as well as limitations and future directions.

2. Stress and Arousal

Stress is according to Lazarus (1991) experienced when we evaluate the demands are greater than our available resources and we can't cope. Humans can activate the stress response simply by thinking about stressful events (such as an upcoming exam). The body reacts with stress to events that are perceived as threat, challenge or barriers (Ulrich-Lai & Herman, 2009).

Two major systems that respond to stress are: the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal (HPA) axis. The HAPA axis regulates the release of cortisol, a hormone produced in the adrenal glands. In moderation is cortisol good aiding learning and increase attentiveness, however high levels of cortisol and under longer period of times can create chronic stress and have detrimental effects on cognitive functions such as memory. Within the ANS lie the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS), which have opposite functions. The SNS controls the "fight or flight" response, preparing the body to meet situational demands. It is activated by the sympathoadrenal medullary (SAM) axis and uses the neurotransmitter norepinephrine. The PNS controls the "rest and digest" response. It is responsible for relaxing and uses acetylcholine as a neurotransmitter. The two systems work together to reach homeostasis (state of balance) since they have different functions, they have different consequences on the body. The SNS prepares the body to act, dilating the pupils to get as much visual information as possible, sweating is increasing to cool down the body, increasing the heart rate to pump blood and oxygen to specific body parts needed for the action and faster breathing also to get more oxygen (Gazzaniga & Ivry, 2013). PNS has the opposite effect on the body, constricting the pupils, slows down the heart and breathing so to go back to homeostasis (Gazzaniga & Ivry, 2013).

Arousal is described as an energized state or readiness to act, and when heightened it primarily activates the SNS, thus energizes behavior. Arousal can range from deep sleep to high levels of excitement (O'Brien & Crandall, 2003). In general, both stress and arousal are terms that are often used interchangeably much because of their similarities. Stress or arousal (depending on which terminology one uses) is often linked to anxiety (Weinberg & Gould, 2011).

3. Anxiety and Academic Performance

In general terms, anxiety is defined as a negative emotional state, triggered in situations that are perceived as threatening or that have real elements of threat (Weinberg & Gould, 2011). Anxiety is characterized by an excessive degree of worry and fear (McDonald, 2001). There is a distinction between *trait anxiety* and *state anxiety*. Trait anxiety is the stable tendency to attend to anxiety across many situations, it is connected to one's personality and people differ in their experience of anxiety. State anxiety is one's current level of anxiety and can be manipulated by simulating stressful situations (Derakshan & Eysenck, 2009). Thus, state anxiety is a combination of trait anxiety and the situational stress which together determines the state anxiety. As such it is not just, for example the testing situation (in test anxiety) that is the primary cause determining the level of anxiety, it is an interaction with the individual's proneness to anxiety in general (McDonald, 2001). Having high state anxiety does not imply high trait anxiety, but individuals with high trait anxiety are more likely to experience state anxiety (Huberty, 2009). Individuals with a biological predisposition of general anxiety can develop the generalized anxiety disorder (GAD). People with GAD are excessively anxious and the anxiety is present across a variety of situations and they have difficulty controlling their anxiety (Morrison, 2014).

3.1. Anxiety Consists of Worry and Emotionality

Within the academic anxiety literature consist anxiety of worry and emotionality. Worry is the cognitive aspect of anxiety; it is the internal dialogue that can be present in for example evaluative situations and is future-oriented. A worried student might begin to compare his own performance with his peers, start thinking more about the consequences of failing the test, questioning his preparations and experiencing feelings of both low confidence and low self-worth (Cassady & Johnson, 2002; Schwarzer, 1980).

Emotionality is the bodily sensations and arousal that an individual perceives when being anxious. Anxious individuals generally experience increased heartbeats, sweating and breathing and some even experience dizziness and feelings of panic. Schwarzer (1980) clarifies that emotionality relies on the individual being aware of the increased arousal; it is the subjective awareness made by the individual and not the arousal itself.

Most research (e.g. Brady, Hard, & Gross, 2018; Cassady & Johnson, 2002; Liebert & Morris, 1967) shows that it is the cognitive aspect of anxiety (the worry) that has the primary negative impact on performance. Emotionality can also impact performance, but only under situations where there also is high level of worry present (Cassady, 2001; Schwarzer, 1980). What complicates matters is that emotionality often (but not necessarily always) trigger worry (Brady, Hard, & Gross, 2018). Even though they tend to co-occur, to fully understand anxiety and how it affect performance we must see the two constructs as related, yet separated (Beilock et al., 2017).

3.2. Academic Anxiety

In academic settings the two most studied and commonly experienced types of anxiety are test and math anxiety. Both share similar physiological and cognitive manifestations (Maloney et al., 2014). I will use the term “academic anxiety” when referring to *both* test and math anxiety.

The central aspect of test anxiety is the fear of evaluation in testing situations. A test anxious student will perform poorly in many different subjects as long as she is in a testing situation (McDonald, 2001). Test anxiety is associated with poor exam scores (Maloney et al., 2014).

Math anxiety is the fear or dread people feel when faced with a math problem. Math anxiety is related specifically to the subject of mathematics, a math anxious student can still perform well in other academic subjects. Math anxiety has two subcomponents: learning anxiety and evaluative anxiety. The former is anxiety related to learning math, such as listening to a teacher lecturing on math. The latter is the feeling of anxiety coming from the evaluation situation (Jamieson et al., 2016). Since math anxiety involves the subcomponent of evaluative anxiety some people are stating that math anxiety is just a form of subject-specific test anxiety (Hembree, 1990).

3.2.1. Developing test and math anxiety. There are multiple possible explanations as to why a student develops either type of anxiety. For example past experiences of failure and repeated difficulty (which tends to lower self-confidence) can generate more frequent as well as intense experiences of anxiety. A biological predisposition of general anxiety can also make the child more vulnerable, young students with test anxiety also tend to have high levels of general anxiety (Huberty, 2009).

In the case of test anxiety some researchers are proposing that the high prevalence of testing situations is to blame, others point to the comparison of academic abilities among the peers (Maloney et al., 2014). Parental pressure is also associated with greater worry and test-irrelevant thoughts for the child (Putwain, Woods, & Symes, 2010; Maloney & Beilock, 2012). In the Revised Fear Survey Schedule for Children, it is evident that children are concerned with `fear of failure and criticism' on which the items `taking a test' and `failing a test' is in the top of that category. In addition, surveys conducted

in the UK show that the item titled “exams” was the most frequently reported source of stress for both boys and girls (McDonald, 2001).

In the case of math anxiety, studies are suggesting that poor math abilities (such as numerical skills) could lay the foundation from which math anxiety could develop (Maloney et al., 2014). However, it could also be vice versa. A possible scenario is that the anxiety leads to a decreased performance thus result in decreased engagement (in the domain of the task being performed), which in turn leads to lower ability. And with time will this result in even higher levels of anxiety, creating a negative cycle (Beilock et al., 2017). The exact direction of this relationship is not clear, but there is research supporting both directions (Foley et al., 2017; Maloney & Beilock, 2012). There could also be a third possibility, that the direction is bidirectional, that it is not one variable affecting the other but rather that both are impacting each other (Foley et al., 2017).

Research shows that parent’s and teacher’s beliefs can be “transmitted” to the child. Parents and teachers who hold the stereotypical belief that “boys are good at math and girls are not” (referred to as a stereotype threat) can make the girl adopt the same belief. This disempowering belief can negatively impact a girl’s math performance (Maloney & Beilock, 2012).

3.3. Attentional Control Theory

Attentional control theory (ACT) is the most recent theory of anxiety and cognitive performance (Derakshan & Eysenck, 2009) and it is based on the previous Process Efficiency theory (Eysenck & Calvo, 1992). Both theories distinguish between *performance effectiveness* and *processing efficiency.* Performance effectiveness is the quality of the performance, measured by for example the number of correct answers on a test. Processing efficiency is the relationship between the effectiveness and the effort or resources that are being put into performing the task. The distinction was made because performance effectiveness was

considered a poor predictor of performance whereas processing efficiency would be a more accurate measure (Eysenck et al., 2007).

High levels of worry are often associated with low levels of performance (see Sarason, 1988, for a review). However, studies are showing that despite differences in levels of anxiety are there not always differences in performance. According to ACT this is because worry impairs performance efficiency more than performance effectiveness. Performance effectiveness may not be impaired because worry generally makes people motivated to minimize the negative effects caused by their anxiety by adding more effort, hence creating a compensatory effect (Eysenck et al., 2007).

According to ACT is anxiety impairing attentional control, which is governed by the central executive. The central executive is the most important component of Baddeley's model of working memory because it controls and regulates the entire system (Baddeley & Logie, 1999). According to ACT are the main functions of the central executive to: inhibit, shift and update information, however, only the inhibition and shifting functions are directly influenced by anxiety. Anxiety impairs the efficiency of the inhibition and shifting functions because they are two types of attentional control (Derakshan & Eysenck, 2009). Miyake and colleagues (2000) states that it is important to recognize that even though "inhibition", "shifting" and "updating" are all involved in the execution of complex tasks and are united, they are still separable, making it possible for anxiety to affect them separately. Owens, Stevenson, Hadwin, and Norgate (2012) found a significant indirect effect of anxiety on academic performance via the central executive.

3.3.1. How the inhibition and shifting functions are affected. Attention can either be influenced by the individual's goals, expectations and knowledge (*the goal driven system*) or by behaviorally relevant stimuli, often salient or unexpected (t*he stimulus driven system*). Both systems frequently interact with each other (Derakshan & Eysenck, 2009).

To focus on one thing, means that we at the same time have to *inhibit* everything else and *shift* the attention towards where we want it to be. Thus, the inhibition and shifting functions works together to inhibit a task-irrelevant stimulus, then shift the attention towards a task-relevant stimulus. However, anxiety tends to make us pay more attention to threat-related stimulus as it increases, which enhances the stimulus driven system (Eysenck et al., 2007). A threat- related stimuli can be internal (e.g. worry) or external (environmental distractions). Research show that anxious individuals tend to develop an attentional bias for threat-related stimuli, they attend less to positive and neutral stimuli and more towards those that are threat-related (Bar-Haim, Lamy, Pergam, Bakermans-Kranenburg, & van Ijzendoorn, 2007). The negative consequences of anxiety on performance will be greater if (1) the task-irrelevant stimuli is perceived as a threat, as opposed to neutral and (2) if the task sets high demands on working memory resources (Eysenck et al., 2007).

In sum, anxiety leads to a heightened focus on threat-related stimuli creating an imbalance between the goal driven and stimulus driven system. Anxiety impairs the efficiency of the inhibition and shifting functions, thus reducing attentional control. Since the inhibition and shifting functions are not working properly even more distractions can occur, ultimately decreasing performance (Derakshan & Eysenck, 2009).

3.3.2. Working memory capacity. Working memory capacity (WMC) is the ability to control the attention long enough to maintain the information in a state that makes it possible to accurately and quickly retrieve it (Engle, 2002). Research shows that anxiety, but more specifically worry, reduces WMC which can have negative consequences on performance (Mattarella-Micke, Mateo, Kozak, Foster, & Beilock, 2011; Owens et al., 2012). People differ in their WMC and studies show that anxiety impairs performance mostly for individuals with high WMC. Individuals with high WMC prefer to use and rely on strategies that require more of the working memory resources making it more problematic when anxiety is present.

Individuals with low WMC mostly use and rely on strategies that are less demanding on the working memory resources and therefore the anxiety is not as harmful to their performance. Individuals with high WMC usually outperform the low WMC individuals under normal circumstances, but when high levels of anxiety are present and the pressure is on, their performance decrease (Beliock, 2008; Beliock & DeCaro, 2007; Ramirez, Gunderson, Levine, & Beilock, 2013).

Owens, Stevenson, Hadwin, and Norgate (2014) found that trait anxiety was positively related to test performance in those with high WMC, suggesting that individuals with sufficient working memory capacity may benefit from some, perhaps *mild* anxiety. One explanation could be that anxiety can make an individual work harder (put in more effort) as an attempt of not letting the anxiety come in the way of performance (Owens et al., 2014).

The nature of the task is also important to consider. Tasks that need strategy-based solutions are not only performed slower but also far more demanding on working memory compared with tasks that are performed through memory retrieval - which is faster and a more automatic process, with little or no demand on working memory resources (Ashcraft & Krause, 2007). Mathematics is one subject in school that sets high demands on working memory resources. Ashcraft and Krause (2007) found that even a simple subtraction task have a substantial working memory component to it, relying on strategy-based processing which differs from memory retrieval. Thus, even a task as simple as subtraction can suffer when being performed by a high-anxious student. Ashcraft & Kirk (2001) investigated how high versus low math-anxious individuals performed on easy (non-working memory demanding) tasks and on more challenging (working memory demanding) tasks. They found that both groups (high and low math anxiety) performed equally well on the easy and non-working memory demanding, tasks. Moreover, did both groups show similar results, with poorer performance when the tasks were more challenging and working memory demanding.

However, the performance drop was greater among the high math-anxious individuals compared to those with low math-anxiety, suggesting that high math-anxious individuals have a decreased WMC relative to non-anxious individuals. Note, there are state and trait differences in WMC (Ilkowska & Engle, 2010). Ashcraft & Kirk (2001) found that that high math anxiety reduces state WMC, which results in decreased performance.

In conclusion, individuals with high trait WMC seem to be more negatively affected by anxiety, but perhaps mild levels of anxiety can be useful. Individuals with high math anxiety demonstrate decreased state WMC and decreased performance on challenging tasks.

3.4. The Anxious Brain

Neuroimaging studies show that anxiety is associated with increased activation in amygdala and reduced recruitment of prefrontal cortical areas, more specifically the dorsolateral prefrontal cortex (dlPFC), and ventrolateral prefrontal cortex (vlPFC). In situations where attentional focus is needed for efficient task performance, these brain areas are very much involved in the process. The dlPFC and vlPFC will be explained in more detail in terms of their functions in the following background section. The cognitive consequences of heightened amygdala activity in combination with reduced prefrontal recruitment seem to create the bias to threat-related stimuli (Bishop, 2007).

4. Cognitive Reappraisal

People respond with different emotions to the same situation depending on how they appraise the situation. In other words how they interpret the situation influences how they feel (Siemer et al., 2007). Cognitive reappraisal is one of the most studied emotion regulation strategies, receiving considerable empirical and clinical attention. Research shows that individuals who use reappraisal frequently experience and express more positive emotions and less negative emotions, have high life satisfaction, closer relationships, lower risk of depression and an overall higher psychological well-being (Gross & John, 2003).

4.1. Emotion Generation and Emotion Regulation Models

According to *the modal model of emotion* (Gross, 1998a), emotions are generated through four steps: *situation, attention, appraisal and response. Situation* refers to the stimulus that is presented (internal or external), the individual then focus their *attention* toward the stimulus (if it's perceived as important). Next is the *appraisal* which is where an individual interprets the stimulus and evaluate its relevance. The final step is where an emotional *response* will be elicited. Emotion generation is an ongoing process, extending beyond a single episode, therefore emotional responses are often changing the situation that gave rise to the response in the first place, creating a feedback loop (Gross & Thompson, 2007).

Based on the modal model of emotion, Gross developed *the process model of emotion regulation* (Gross, 1998b). According to the model it is possible to regulate emotions at each of the five points in the emotion generative process. The five points, represents the five families of emotion regulation processes and they are: situation selection, situation modification, attentional deployment, cognitive change and response modulation. *Situation selection* refers to regulating one's emotions by either approaching or avoiding certain objects, places or people. Examples of this kind could be to avoid a person you dislike or rent a funny movie after a bad day at work. Situation selection is the first emotion regulation process and it intervenes before the emotions even started. *Situation modification* is when we directly modify the situation to alter the emotional impact. Situations that have the potential to elicit strong emotions do not inevitable lead to emotional responses, because we can change the emotion by changing the situation itself. The third regulation process is *attentional deployment,* it is when attention is redirected within a given situation. In other words it is the shifting of attention either towards or away from the situation in attempts to influence the emotions. It can be accomplished through *distraction, concentration or rumination*.

Distraction is aiming the attention on non-emotional aspects of the situation or moving the attention away, such as watching a funny movie when you are sad or thinking about good memories when you are feeling down. Concentration is actively choosing what to mentally focus on in order to regulate the emotions. Concentrating involves fully utilizing the cognitive resources within an activity. Rumination is directing the attention to feelings and their consequences, ruminating on negative emotions can in the long-term lead to severe depressive symptoms. When ruminating on worry the individual is focusing on the possibility of future threats which can lead to long-lasting anxiety. The fourth regulation process is *cognitive change*, it refers to the meaning we give the situation which influences the emotional response. In other words by changing how we appraise the situation we can alter its emotional significance, either by changing how we think about the situation or our capacity to manage the situational demands. One form of cognitive change is *cognitive reappraisal*, and it is one of the most studied emotion regulation strategies often used to decrease negative emotions. Cognitive reappraisal involves changing a situation's meaning in such a way that there is a change in the person's emotional response to that situation. Another form of cognitive change is *reframing*, which refers to viewing the situation or event in a more positive light, for example reframing the experience of failure into success. The final regulation process is *response modulation* which involves influencing the physiological, experiential, or behavioral responding as directly as possible. Once the emotional response has been elicited it can be modulated by for example drugs, alcohol or exercise if the goal is to lower emotional stress. Expressive suppression is one form of response modulation, it is when an individual tries to inhibit ongoing negative or positive emotions. Research shows that suppressions have counterproductive effects, typically leading to a paradoxical increase of the unwanted emotions (Gross, 1998b). Hofmann, Heering, Sawyer, and Asnaani (2009) found that anxious individuals who used suppression as a strategy actually experienced more anxiety.

According to Gross (1998b) is the regulation process moving along a spectrum, from conscious, effortful, and controlled regulation to unconscious, effortless and automatic regulation. Emotion regulation is a dynamic process, often altering the context that gave rise to the emotion in the first place. Regulation that happens *before* the emotion is generated is called antecedent-focused strategy, such as cognitive reappraisal. Regulation that occurs *after* the emotion is generated is called response-focused strategy. Targeting the early stages seems to be more effective at decreasing the emotional response compared to later stages (Gross, 1998b).

4.2. The Appraisal Theory of Stress and Coping

Essential to the appraisal theory of stress and coping (Lazarus & Folkman, 1984) is that the stress response is affected by the cognitive appraisal processes and can be altered by changing the perception of the stressor. There are two appraisals: the primary and the secondary. The *primary appraisal* is the evaluation of what's at stake in a specific situation and its relation to the person's values, beliefs and goals, consideration aspects such as the motivational relevance and how that motivation corresponds to the individual's beliefs, motives and goals. The motivational relevance has been shown to influence the intensity of the experienced emotions, thus a situation that is evaluated as highly relevant to one's well-being elicits a more intense emotional response (Lazarus & Folkman, 1984). Furthermore, individuals that view a situation as consistent with their goals experience different emotions compared with those who experience inconsistencies (Smith & Kirby, 2009). In simple terms the primary appraisal is an interpretation of the stressors, evaluating them as either harm (already experienced), threat (anticipated harm) or as a challenge (potential for mastery or gain). The *secondary appraisal* is analyzing the available resources and evaluating how to cope. Coping refers to the cognitive and behavioral efforts made by the individual to manage the demands (internal and external). Coping can either be problem-focused: dealing with

distress (extreme anxiety, pain or sorrow) by addressing the root cause, or emotion-focused: regulating one's emotions to the problem. People use both types of coping in all sorts of stressful situations. Even though primary appraisal is the first appraisal in the temporal sequence it does not mean that it has the largest impact and alone determines the affective response. The purpose of the secondary appraisal is to evaluate the coping resources available in that specific situation, thus inform affective responses. If an individual first perceives a situation as threatening (the primary appraisal) the emotional response can be changed if she later evaluates the coping resources a sufficient (the secondary appraisal) (Folkman, Lazarus, Gruen, & DeLongis, 1986; Lazarus & Folkman, 1984). Vice versa also applies, if for example a student with previously successful experiences, enters a high-stakes test, the primary appraisal would be "challenge". However, if the student realizes that the test is much harder than expected, the secondary appraisal would evaluate the demands as higher than the available coping resources, interpreting the stressor as a threat (Jamieson, 2017).

4.3. The Brain and Cognitive Reappraisal

Reappraisal alters the subjective emotional experience by successfully decreasing or increasing the emotional response to the event (Ochsner, Bunge, Gross, & Gabrieli, 2002). In a typical reappraisal experiment, participants in the reappraisal condition are given a fair amount of training on how to reappraise the emotional stimuli before they enter the scanner. Participants, both those in the reappraisal condition and those in the control group are presented with emotional stimuli, for example a film clip or picture that is specifically designed to elicit a negative affective response. The majority of studies on reappraisal focus on reducing negative emotions while looking at negative pictures from the International Affective Picture Set (IAPS), in either young healthy adults or older adults. Once presented with the emotional stimuli, participants in the reappraisal condition are instructed to use the reappraisal strategy; they generate an alternative interpretation of the stimuli which changes

the emotional response. Participants in the control group are instructed to simply react as usual to the emotional stimuli. The brain activity is recorded from both groups and then compared to each other (Gazzaniga & Ivry, 2013). The most common way to study the neural bases of reappraisal is to rely solely on main effect contrast that compares reappraisal to a baseline condition. It offers the most straightforward way to establish the brain regions that supports reappraisal (Buhle et al., 2014). Being exposed to a negatively charged stimulus activates not just a single brain area but rather a broad network, including the medial prefrontal (mPFC) and anterior cingulate (ACC) cortices (Etkin, Egner, & Kalisch, 2011). Explained in simple terms, reappraisal have been found to increase activity in the prefrontal cortex (PFC) and decrease activity in the amygdala (van Reekum et al., 2007; Ochsner et al., 2004) and in some cases also decrease insula activity (Ochsner & Gross, 2008). The neural systems involved in generating emotional responses and those involved in regulating emotions are described below.

4.3.1. The neural systems of the generation of emotional response. Systems involved in generating emotional responses are amygdala, ventral striatum (VS) and insula. These three brain systems in addition to the ventral medial prefrontal cortex (vmPFC) are according to Ochsner and colleagues (2012) believed to play a key role in reappraisal and most widely mentioned in the literature.

4.3.1.1. Amygdala. Amygdala is believed to process the emotional significance of external stimuli and thus modulates and affects the cognitive functions of attention, perception and explicit memory (LeDoux, 2007). Amygdala responds not only to aversive stimuli, such as fearful facial expressions and negatively charged pictures, but it also responds to positive stimuli, such as rewards. Since most reappraisal studies aim to down-regulate negative emotion, the amygdala activity is typically decreased. However, when the goal is to up-regulate positive emotions, is the amygdala activity increased (Silvers et al., 2013).

4.3.1.2. Ventral striatum. Ventral striatum is a major part of the basal ganglia and is involved in learning and predicting rewards (Ochsner et al., 2012). Reappraisal of both positive and negative emotions induces changes in the ventral striatum. Ventral striatum shows more increased activation during regulation of positive emotions compared to negative (Silvers et al., 2013). The amygdala and ventral striatum detect the affective significance of a stimulus. This information is later sent to vmPFC, which integrates it with input from other regions such as the medial temporal lobes, the brainstem and the PFC (Ochsner et al., 2012).

4.3.1.3. Insula. The insula gathers all the visceral and somatic input to create a representation of the body's state. The more posterior regions of the insula are associated with the representation of sensations from the body, whereas more anterior regions are associated with motivational and affective states. For example, the feeling of disgust has a strong visceral component and found in the more anterior regions (Silvers et al., 2013). The insula has extensive connections with the amygdala, medial prefrontal cortex and anterior cingulate gyrus. The insula is also connected to the frontal, parietal and temporal cortical areas, which are involved in attention, memory and cognition. Studies show that both the anterior insula and the anterior cingulate cortex are involved in the experience of emotional feelings (e.g. romantic love). It is hypothesized they integrate cognitive and emotional information (Gazzaniga & Ivr y, 2013).

4.3.2. The neural systems of emotion regulation. Regions believed to regulate emotions are: dorsomedial prefrontal cortex (dmPFC), dorsolateral prefrontal cortex, inferior parietal cortex (iPC), dorsal anterior cingulate cortex (dACC), posterior prefrontal cortex (pPFC) and ventrolateral prefrontal cortex (Ochsner et al., 2012). In a recent meta-analysis conducted by Buhle and colleagues (2014) found activation in brain areas: dmPFC, dlPFC, vlPFC as well as the posterior parietal lobe during reappraisal.

4.3.2.1. The prefrontal cortex. As mentioned before, activity in prefrontal cortex is increased when using reappraisal to decrease negative emotions. Prefrontal cortex is essential in the neural circuitry that supports cognitive control. Cognitive control is defined as the set of processes that guide thought and action in accordance with current goals, and cognitive reappraisal is one form of cognitive control (Gazzaniga & Ivry, 2013). Different parts of the prefrontal cortex are activated during reappraisal, below will them be explained in more detail and their implicated functions.

4.3.2.2. Dorsomedial prefrontal cortex. This region is suggested to be involved in self-monitoring and self-evaluations of emotions (Ochsner et al., 2004). The more anterior parts of dmPFC have also been proposed to reflect evaluations about mental states of oneself and others. This region might be relevant both in the assessment of the effects the initial appraisal has on one's mental state, as well as assessing the new mental states following the new appraisal (Silvers, Buhle, Ochsner, & Silvers, 2013).

4.3.2.3. Dorsolateral prefrontal cortex. This region is widely implicated in executive control processes (Gazzaniga & Ivry, 2013). The dlPFC is activated during many different types of cognitive tasks, as well being involved in working memory, reasoning, social cognition and cognition in general. Moreover, it is suggested to be involved in response selection as well as having a role in reward processing. It is an area that seems to be important for emotion regulation (Kohn et al., 2014). Buhle and colleagues (2014) meta-analysis suggest the dlPFC is involved in the manipulation of appraisals in working memory. Increased activity in dlPFC has been found in fMRI studies when individuals perform complex working memory tasks, such as when maintaining a large amount of information in working memory. Furthermore, when controlling one’s attention both dlPFC and anterior cingulate cortex (ACC) are involved. It is proposed that ACC activity is related to the detection of conflict, which then signals the need for increased cognitive control that is implemented by the dlPFC

(Gazzaniga & Ivry, 2013). Moreover, is it suggested that dlPFC and inferior parietal cortex (iPFC) together directs attention to reappraisal-relevant features of the stimuli, holding in mind the reappraisal goals and manipulate information during the development of new appraisals (Silvers et al., 2013).

4.3.2.4. Ventrolateral prefrontal cortex. This region is linked to different types of emotion processing, social cognition and action inhibition, having a direct connection to the amygdala (Kohn et al., 2014). It seems to be involved in both generation and regulation of emotion (Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008). In the case of reappraisal is it believed to support selection and inhibition of appraisals (Buhle et al 2014; Ochsner et al., 2014). The left part of vlPFC could be used to deliberately develop a new reappraisal, whereas the right vlPFC may serve to inhibit one's initial appraisal in favor of a goal-congruent reappraisal (Silvers et al., 2013).

4.3.2.5. Ventromedial prefrontal cortex (vmPFC). In some reappraisal studies, activation in (vmPFC) has been found, with one view holding that it modulates amygdala responses. It seems to be integrating information, such as affective valuations of a certain stimuli with inputs from other regions (e.g. medial temporal lobe systems) that provides historical information about past encounter with the stimuli, as such setting the positive or negative valuations of a stimuli in a context (Ochsner et al., 2012). vmPFC has a documented role in behavioral inhibition, more specifically inhibiting passive fear reactions such as freezing (Gazzaniga & Ivry, 2013). It is crucial in fear extinction, which is a form of down-regulation of negative emotions (Silvers et al., 2013). To date, there seems to be no general agreement on the role vmPFC has in the reappraisal process (Kohn et al., 2014). Some suggest that it integrates; semantic and memory information (from the medial temporal lobes), and affective appraisals with current goals (e.g. Ochsner et al., 2002). Other (Kohn et al., 2014) have proposed that it may evaluate our emotions, as such determining the need for

regulation. Some researchers even question if it has a role, since a recent meta-analysis of 48 studies found no activation in that region during reappraisal (Buhle et al., 2014).

4.3.3. Reappraising high versus low- intensity emotions. Silvers, Weber, Wager, and Ochsner (2014) investigated if reappraising high versus low-intensity emotion would activate different brain areas. Participants did one of the following: (a) look at the neutral image and respond naturally, (b) look at the negative image and respond naturally, or (c) reappraise the negative image. Participants were instructed to reinterpret the outcome and/or reality of the events that were shown, in such a way that the emotional response decreased. For example, being cut off by a sports car can evoke high intensity emotions, but the emotions can be decreased if the situation is reinterpreted as the driver driving aggressively because he was rushing to get his pregnant wife to the hospital. Participants reported how strongly negative they felt by the pictures on a scale ranging from 0 (not negative at all) to 4 (very negative), and the emotional intensity were calculated for each picture based on the ratings. Silvers and colleagues (2014) found that emotions of high-and low-intensity seems to recruit the same neural systems during successful reappraisal. However, reappraising high-intensity emotions more strongly activated the left dlPFC, the right lateral and dorsomedial PFC regions, compared to low-intensity emotions. They suggested that the enhanced left dlPFC activity reflects the desire to reduce unpleasant feelings, to a greater extent when experiencing high-intensity of negative affect, therefore are more cognitive resources needed to serve the goal. Reappraisal relies heavily on the ability to hold and manipulate reappraisals in working memory, to select relevant information and to monitor one's emotional state regardless of high or low-intensity emotions.

4.4. Beliefs Influential Role in Emotion Regulation

Studies show that beliefs about emotions, believing that they are fixed or malleable influence emotion regulatory behavior. Individuals with fixed beliefs are more likely to disengage from challenging situations because they believe that the challenge is outside of their control, that no matter how much effort they put into the task it won't matter. By contrast individuals with malleable beliefs face the challenges and use more assertive patterns of coping (Tamir, John, Srivastava, & Gross, 2007). Kneeland, Nolen-Hoeksema, Dovidio, and Gruber (2016) found that participants who believed emotions are malleable engaged spontaneously more in cognitive reappraisal during a stressful task compared to those who believed emotions are fixed. Individuals with a fixed emotion belief used more of expressive suppression, which is a less effective approach in regulating negative emotions (Kneeland et al., 2016). Thus, the likelihood of engaging in emotion regulation strategies, such as cognitive reappraisal, will be greater if the individual holds a belief that emotions are malleable. Not only are beliefs about emotion in general affecting emotion regulation, but belief about one's *own* emotions have an even greater influence (De Castella et al., 2013; Tamir et al., 2007).

Beliefs about emotions being bad or good also matter, people who hold a belief that emotions are bad, when experiencing stress, have a heightened emotional response. Thus, it is important to remember that not all emotions that are unpleasant are bad, and not all pleasant emotions are good (Ford & Gross, 2019).

Moreover, Bigman, Mauss, Goss, and Tamir (2016) found that expected success promotes actual success in emotion regulation. If you expect to be successful in regulating your emotions, you are more likely to actually be it.

Ending with words by Gutentag, Halperin, Porat, Bigman, and Tamir (2017) successful emotion regulation require both conviction and skill.

5. Cognitive Reappraisal and Academic Anxiety

Many studies have been conducted within the field of cognitive reappraisal, however, not many studies have investigated reappraisal in the context of academic anxiety and performance. According to Harley, Pekrun, Taxer, and Gross (2019) a student's academic success depends partially on how she regulates her emotions, therefore the skill of emotion regulation is highly important in the domain of academia. Despite emotion regulation's relevance, so far to my knowledge, there are only a handful of studies using reappraisal in academic contexts.

5.1. The Biopsychosocial Model of Challenge and Threat

The Biopsychosocial (BPS) model of challenge and threat (Blascovich, 1992) provides a theory of how appraisals shape stress responses and it builds upon Lazarus's appraisal theory of stress and coping and Gross's process model of emotion regulation According to the theory, arousal is simply the consequence of engaging within a motivated performance situation and in that type of context an individual can experience either challenge or threat-type responses, based upon the individual's appraisals. Whereas in Lazarus's model the appraisals are divided into primary and secondary, in the BPS model, is the individual only making a single appraisal. The single appraisal is an evaluation of both the situational demands and the available coping resources (Jamieson, 2017).

Challenge is appraised when the resources are greater than the demands and is associated with feelings of enjoyment, pride, excitement, increased self-esteem and lower levels of subjective stress (Jamieson, 2017; Skinner & Brewer, 2002). In addition it is been linked to increased performance. Threat is appraised when the demands are greater than the resources and is associated with feelings of anxiety, shame and decreased self-esteem (Skinner & Brewer, 2002). Threat appraisal is also associated with debilitated cognitive performance (Jamieson, 2017). As mentioned before, the negative consequences of anxiety

will be greater if a stimulus is perceived as a threat as opposed to neutral (Eysenck et al., 2007). The type of appraisal also influences behavior; challenge appraisal is associated with a motivation to approach the situation, whereas threat appraisal is associated with an avoidance behavior (Jamieson, 2017).

When we experience anxiety, according to Lazarus (1991), we appraise the stress as threat, highlighting the uncertainty of the situation, which makes us feel powerless and in turn we show avoidant behavior.

5.1.1. Physiological responses. The primary stress systems: the SAM and HPA are activated in a motivated performance situation. Both systems mobilize the resources so that an individual can respond to the stressor. The SAM system activates instantaneous whereas the HPA system is slower and more difficult to activate. However, once the HPA system is active it is harder to "turn off" and it often results in more negative effects. Both appraisal of challenge and threat is hypothesized to activate the SAM system. However, the HPA system is only thought to be activated by threat appraisal. Challenge appraisal is associated with increased cardiac efficiency and decreased blood pressure, whereas threat appraisal is associated with reduced cardiac efficiency and increased blood pressure. Challenge appraisal recovers fast after stress, compared to threat appraisal where the recovery is slow and the stress response linger (Jamieson, Hangen, Lee, & Yeager, 2018a).

5.1.2. Appraisals along a continuum. The ratio of resource versus demand appraisals determine whether it becomes a challenge appraisal or threat appraisal, resulting in either challenge or threat-type responses (physical responses). Note, however that appraisals, according to Jamieson et al. (2016) like anchors are moving along a continuum, where the ratio of perceived resources to demands shifts. In an exam a student that is experiencing threat can move more toward challenge if she perceives that she has studied efficiently (increased

resources) or believed the exam questions were easy (decreased demands) or both (Jamieson et al., 2016).

5.2. The Arousal Reappraisal Intervention

In the classic emotion regulation research reappraisal is focusing on reinterpreting the situation or one's place in it (e.g. adopting a third-person perspective) (Ochsner & Gross, 2008). Hofmann et al. (2009) found that reappraising an anxiety-provoking situation moderates the subjective feeling of anxiety and even more so than attempts aimed at suppressing or accepting the anxiety. However, the research on reappraisal in the context of academia is not targeting the meaning of the situation but rather reinterpreting the internal bodily state that accompanies stress and anxiety. The interpretation of one's physiological state can be one key factor in whether an individual chokes (underperforms) or strives in a stressful situation. Anxious individuals may be more prone to interpret their physiological responses (e.g. increased arousal), elicited by a stressful event as a negative cue and therefore perform poorly (Mattarella-Micke et al., 2011). A racing heart is an example of increased arousal, which is most often a sign of a stressful situation, and is frequently interpreted as anxiety, nervousness or fear (Jamieson, Nock, & Mendes, 2012). However, anxiety does not have to be negative, it can be good and even helpful (adaptive) if the state of arousal leads to productive action (Killu, Marc, & Crundwell, 2016). Thus, increased arousal must not be an indicator of anxiety and threat, but can be the body signaling a readiness to meet the task demands. Research shows that stress can set the brain and body in a position of optimal functioning (Crum, Salovey, & Achor, 2013). An intervention called arousal reappraisal, or sometimes stress reappraisal; aims to improve individuals stress response and performance by targeting their perception of their own arousal and anxiety.

Jamieson, Mendes, Blackstock, and Schmader (2010**)** conducted the first study to experimentally manipulate appraisal processes, using the arousal reappraisal intervention, to

investigate the effect on actual test performance. Sixty students (31 male, 29 female) participated in the study, all planning to take the real Graduate Record Examination (GRE) test within 3 months. All sixty students took the practice GRE test in the laboratory, but only 28 of them also took the real test within the required time-window. To have an objective measure of sympathetic nervous system activation were salvia samples of alpha amylase (sAA) collected at baseline and after students used the arousal reappraisal intervention. Participants assigned to the reappraisal group were told that arousal improves performance:

> *''People think that feeling anxious while taking a standardized test will make them do poorly on the test. However, recent research suggests that arousal doesn't hurt performance on these tests and can even help performance... people who feel anxious during a test might actually do better. This means that you shouldn't feel concerned if you do feel anxious while taking today's GRE test. If you find yourself feeling anxious, simply remind yourself that your arousal could be helping you do well."*(p.209).

The control group was not given any information besides simply perform your best as usual. The results showed that the reappraisal group exhibited increased arousal and outperformed the control group on the math section of the test. Similar results were found, one to three months later when the real GRE test scores were collected. Participants in the reappraisal condition, on the practice GRE test, had a mean score of 738.57 (it could range from 200-800) and participants in the control group had 683.57 points, it is considered a large effect size (a large difference). On the real GRE test had the reappraisal condition a mean score of 770.00 compared to controls 705.71, which also is considered a large effect size. The reappraisal participants also reported that the arousal helped their performance; they worried less about feeling anxious and felt less unsure of themselves. Due to similar results found in both the

laboratory and on the actual GRE test, it suggests that the arousal reappraisal intervention may work in real-life testing situations.

Jamieson et al. (2012) exposed fifty participants (25 female, 25 male) to a stressful public speaking task while being evaluated by two evaluators. During the task their cardiovascular responses were recorded by electrocardiogram (ECG), Impedance cardiography (ICG) and blood pressure, and followed by the emotional Stroop task to assess attentional bias. Distinctions between challenge and threat states are made by measuring for example cardiac output (CO), increases in CO index means improved cardiac efficiency. Participants were also give questionnaires to assess: their resource/demand appraisal, their subjective perception of stress and effort as well as completing the Positive and Negative Affect schedule (PANAS). Participants were assigned to one of three conditions: (a) reappraisal participants were instructed that arousal is functional and aids performance, (b) ignore the external cues given by an evaluator, and (c) a control group, given no instructions (non-intervention). In this study the reappraisal intervention was not the short paragraph like in Jamieson et al. (2010) study but rather participants were asked to read short summaries of articles and then answer some questions (see Appendix B). Jamieson and colleagues (2012) found the reappraisal group reported increased perceptions of available resources. As well as improved cardiovascular functioning -demonstrating a more adaptive cardiovascular stress response and increased cardiac efficiency. Furthermore had threat-related attentional bias decreased, findings that demonstrate that the reappraisal intervention can generate both cognitive and physiological benefits. In addition showing that how we interpret our bodily signals affects how the body and mind respond to the stress.

Reappraising arousal has also been found positively affecting patients suffering from social anxiety disorder (SAD**).** Seventy-two adult participants were recruited, 42 women and 30 men with a mean age of 26.63. A few participants dropped out so 33 individuals were in

the SAD group and 34 were non-anxious participants. This study was similar to the one mentioned above, participants would either be evaluated by two evaluators or given no evaluation while delivering a speech and doing similar physiological measures. Both SAD patients and non-anxious participants exhibited increased resource appraisals, adapted better to the physiological reactivity and reduced their attentional bias. Findings suggest that even patients suffering from SAD also can benefit from reappraising arousal (Jamieson, Nock, & Mendes, 2013a).

Beltzer, Nock, Peters, and Jamieson (2014) found that SAD patients who used the arousal reappraisal intervention displayed less shame and anxiety, showed a less avoidant behavior and performed (the evaluative speech) marginally better compared to participant in the control group. Results highlighting that reappraising arousal also impacts behavioral displays. Higher levels of coping resources, relative to task demands, were also reported by the reappraisal participants.

To my knowledge the first study to test the arousal reappraisal intervention *outside* the laboratory and in a real-life classroom, was conducted by Jamieson, Peters, Greenwood, and Altose 2016. Ninety-three students (64 females and 29 males, with a mean age of 29.40) were randomly assigned to the double-blind field experiment. The target sample differed from the previous study (Jamieson et al., 2010), in this study were the participants not high-achieving students but rather developmental math students at a community college. The study was divided into two sessions, during session 1 the participant's math anxiety and stress appraisal were assessed once collected where the participants allowed to take Exam 1. The scores on Exam 1 were used to randomly assign participants into either the intervention group or the placebo group, this to eliminate that the two groups differed. Procedures or session 1 and 2 were identical with the exception that the arousal reappraisal intervention was given before participants completed the questionnaires (assessing math anxiety and stress appraisals). Math

anxiety was assessed using the Abbreviated Math Anxiety Scale, and stress appraisals were assessed with questions that demonstrated resource vs demand appraisals, for example "I view this math test as a positive challenge" ranging on a 7-point scale. The arousal reappraisal intervention differed from Jamieson et al. (2010, participants were instructed to read summaries of scientific articles which described and educated about the adaptive functions of stress, and after each summery answered participants some questions (see Appendix A).Materials took approximately 5-8 minutes to complete. Participants in the placebo condition read summaries that suggested to ignore the stress. The use of a placebo group as opposed to a no- instruction control was according to the authors necessary to keep the instructor blind and to account for time spent on materials. Jamieson et al. (2016) found that the arousal reappraisal intervention was associated with increased resource appraisals. They also found that resource appraisals seem to have a mediating role in the relationship between the arousal reappraisal intervention and improved performance. Participants in the reappraisal condition decreased their math anxiety compared to controls, note, however that the difference between the two groups were not large but rather medium in size. Participants who received the arousal reappraisal intervention performed better on Exam 2 than on Exam 1 compared to controls, however again were the effect size only medium. Jamieson and colleagues (2016) also compared the two groups in terms of final course grade and found no significant effect, but the authors states that the reappraisal condition exhibited *marginally* higher course grades than controls, suggesting that the intervention could *possibly* have a long-term effect.

Brady et al. (2018) conceptually replicated Jamieson's et al. (2010) study to test the arousal reappraisal intervention's generalizability, with a larger sample, in a domain other than mathematics and in the context of a real-life classroom. Participants were students in an introductory collage psychology course. In the first part of the study (with 245 participants)

were differences between the first-year students and upper-year students assessed, in terms of their emotionality, worry and knowledge of how to perform well before the first exam. Students reported all items on a 7-point scale (1= not at all, 7= extremely) and the results showed that first-year students reported greater emotionality, greater worry and having less knowledge of how to perform well on the upcoming exam, compared to upper-year students. In the second part of the study the arousal reappraisal intervention (the short paragraph) was investigated, 431 students (58 % women and 42 % men) randomly assigned to either a reappraisal condition or a control group, with an even distribution of first- and upper-year students. The arousal reappraisal intervention was given the night before the exam in an e-mail. Emotionality and worry measures were completed *after* the students had received the intervention and completed the first exam. Emotionality was assessed with the question "during the exam, how anxious or aroused did you feel?" Worry was assessed with two questions: "during the exam, how worried about feeling anxious/confident in your performance were you?", ranging on a 7-point scale. Students' results on Exam 1 as well as their final course grade were collected. As hypothesized by the authors, the reappraisal intervention had no effect on the college student's reported emotionality however it did reduce their worry. Moreover, as expected the students in the reappraisal condition performed better on the exam than those who didn't receive the arousal reappraisal intervention, note however that the difference between the two groups were only small in size. Interestingly were these results only found on the first-year students but not on the upper-year students. The first-year students who received the reappraisal intervention also increased performance in their overall final course grade, suggesting long-term effect; however, as before the effect size was only small.

The arousal reappraisal intervention has also been tested in the area of stereotype threat. Stereotype threat undermines performance by depleting working memory resources, in

a similar manner as academic anxiety affects performance (Beilock et al., 2017). Stereotype threat is the fear of confirming a negative stereotype. Research shows that people underperform in evaluative situations when reminded that they belong to a group associated with weakness in that specific domain (Alter, Aronson, Darley, Rodriguez & Ruble, 2010). By reducing the stereotype threat the students perform better (Walton & Spencer, 2009). Women underperform on math tests if they are reminded about their stereotype threat (women are bad at math). Johns et al. (2008) found that women under stereotype threat who received the instructions that anxiety (they used different terminology) does not hurt but rather aids performance increased their performance compared to controls. Another study by John-Henderson, Rheinschmidt, and Mendoza-Denton (2015), used Jamieson and colleague's (2010) "short-paragraph", found that not only did it help performance on a math test but it also decreases levels of cytokine (an immune marker of inflammation) for women under stereotype threat. The results suggest that the arousal reappraisal intervention could also be useful in the area of stereotype threat.

The concept of the arousal reappraisal intervention, reappraising arousal as beneficial to performance, has also been investigated in sport settings on motor tasks (golf puts). The reappraisal group displayed a cardiovascular response, reflecting a challenge state and outperformed the control group. Performance was measured by the distance between the ball and the hole, the reappraisal group were 8.64cm from the hole, compared to the controls who were 29.92cm from the hole. Thus, reappraising arousal can optimize performance under pressure (Moore, Vine, Wilson, & Freeman, 2015). By reappraising arousal it promotes a challenge state, with better cardiac efficiency, increase self-confidence and resource perception (Sammy et al., 2017).

Crum et al. (2013) found that believing that stress can be beneficial, having a "stress-is-enhancing mindset" improved health and work performance. The "stress-is-enhancing mindset" share similarities to the reappraisal intervention.

Since students are in motivated-performance situations with task-demands that require direct responding, the goal is not to decrease the arousal, but rather to focus on the benefits and as such promote adaptive high-arousal affective states, harnessing the heightened arousal. Brooks (2014) found that trying to calm down can be an ineffective approach that fails to decrease arousal and down-regulate anxiety. Participants who were instructed to reappraise their anxiety as excitement as oppose to trying to calm down, showed better performance across several studies, one being a math test. Brooks (2014) states that excitement is arousal congruent, meaning that it is easier to reappraise high anxiety to an emotion that is similar in the level of arousal, whereas it is harder to reappraise high levels of anxiety (having high levels of arousal) to calmness since calmness is an emotion that is not congruent with the level of anxiety (Brooks, 2014). Moreover, when viewing anxiety as negative to performance it creates a perception of the demands exceeding the resources, triggering a maladaptive threat response. By modifying resource appraisals, as when viewing the benefits of increased arousal, the resources become greater than the demands, which create a challenge appraisal and thus improves performance (Jamieson et al., 2012).

6. Discussion

This thesis had two aims; the first was to investigate what happens in the brain during cognitive reappraisal. The brain is a mysterious organ that is highly complicated. Even though we have come a long way in deepening our understanding of the brain and what different brain areas are activated during different types of tasks, there is still much left for us to learn. What happens in the brain during cognitive reappraisal has today no clear and simple answer, much because reappraisal is among the most cognitively complex strategies, engaging

many different higher cognitive processes; such as language, memory, attention and response selection (Ochsner et al., 2012). Different studies find somewhat different results, much depending on the study, the type of stimuli and what emotions that have been elicited. However, among the most consistent findings in the literature of reappraisal are changes in amygdala activity (Buhle et al., 2014). Research has demonstrated, explained in simple terms, that when we down-regulate negative emotions (by reappraisal) there is increased activity in PFC and decreased activity in amygdala (Oschner et al., 2004; van Reekum et al., 2007), and in some cases also decreased activity in insula (Oshner & Gross, 2008). The findings are somewhat inconsistent, especially the role of vmPFC with some studies finding activation during reappraisal while others don't (Buhle et al., 2014). What seems to be a general understanding is that cognitive control regions such as dmPFC, dlPFC and vlPFC are activated during reappraisal (e.g. Buhle et al., 2014; Ochsner et al., 2012; Silvers et al., 2013). They have functions such as manipulating appraisals in working memory, selects new appraisals and inhibits old appraisals, as well as support different processes responsible for affective meaning and perception of one's own emotional state (e.g. Buhle et al., 2014).

Participants in a typical reappraisal experiment receives a fair amount of training on how to reappraise emotional stimuli before they even enter the scanner, however, emotions can be regulated automatically and unconsciously which makes research on cognitive reappraisal difficult. How can we know for certain that when participants are asked to reappraise a negative stimulus, that they are doing it and nothing else besides that, and that the control group are not doing any type of regulation? Moreover, the brain areas that have been found during reappraisal mostly demonstrates correlational data, which we can't draw any causal conclusions from (van Reekum et al., 2007).

The most common way to study the neural bases of reappraisal is to rely solely on main effect contrast that compares reappraisal to a baseline condition. It offers the most straightforward way to establish the brain regions that supports reappraisal. However, to rely solely on the "subtraction approach" (activity in a control task is subtracted from activity in an experimental task) creates a risk of sometimes overlooking brain regions that generally supports both reappraisal and either emotion generation or spontaneous emotion regulation. Therefore Buhle et al. (2014) highlights that future studies have to employ novel paradigms to address this problem. Moreover, future studies need to broaden the understanding of the roles that the brain systems which supports emotion regulation have (Ochsner et al., 2012). Also, given that there are question marks regarding vmPFC role in the reappraisal process, is there a need for future studies to investigate it (Buhle et al., 2014).

The second aim sought out to answer how cognitive reappraisal could be used as a strategy for dealing with academic anxiety. Increased arousal can be interpreted as anxiety and as such impact performance negatively, however, by reinterpreting the increased arousal as beneficial to performance (using the arousal reappraisal intervention), which may possible prevent underperformance caused by anxiety. According to the BPS model (Blascovich, 1992) this is because we now view the resources as greater than the demands, creating a challenge response instead of a threat response, thus improving performance. The majority of research shows that it is the cognitive aspect of anxiety (the worry) that harms the performance, and since reappraisal targets cognition, it becomes a suitable strategy. The studies are few but the results are promising, **s**howing that the arousal reappraisal intervention possibly can improve exam performance (Jamieson et al., 2010; Jamieson et al., 2016, Brady et al., 2018), decrease math anxiety (Jamieson et al., 2016), decrease worry (Brady et al., 2018), increase resource appraisals which have a mediating role in the relationship between the intervention and increased performance (Jamieson et al., 2016). Moreover, the arousal

reappraisal intervention; improve cardiac efficiency (Jamieson et a., 2012; Sammy et al., 2017), optimize motor task performance (Moore et al., 2015; Sammy et al., 2017), reduce threat-related attentional bias (e.g. Jamieson et al., 2013a), help women under stereotype threat perform better (Johns et al., 2008; John- Henderson et al., 2015) and even benefit SAD patients (Jamieson et al., 2013a). The studies on reappraising arousal, suggests that increased arousal can facilitate performance, the reappraisal participants increased their arousal *more* after been given the intervention, (e.g. Jamieson et al., 2010) findings that implies that the harm of increased arousal does not lie in the physiology but rather in the mind. Below, is the arousal reappraisal intervention discussed in more detail in terms of generalizability, long term effect, practical implications, etc.

6.1. The Generalizability of the Arousal Reappraisal Intervention

The arousal reappraisal intervention have so far, only been tested in a few studies on older participants; with a mean age of 29.40 (Jamieson et al. 2016) and college students (Brady et al., 2018), this means that it is unclear whether it actually can work on younger students.

Some researchers question if the arousal reappraisal intervention is effective for other school subjects besides mathematics because several studies have used math tasks as a measure of performance (Jamieson et al., 2016; Johns et al., 2008). Moreover, Jamison and colleagues (2010) only found the intervention to be effective for the math section in the GRE test and not the verbal section. One explanation can be that math tasks set higher demands on working memory resources in comparison with verbal tasks (Brady et al., 2018). Studies show that working memory resources, such as working memory capacity is very much affected by the cognitive aspect of anxiety (Mattarella-Micke et al., 2011). However, if it is a matter of demands on the working memory resources, then the arousal reappraisal intervention's effectiveness is not a matter of school subject. Thus, all school subjects that set high demands

on working memory resources could benefit from the arousal reappraisal intervention. Brady and colleagues (2018) tested the intervention on a large sample of participants in a psychology course and suggest that it has the potential to be effective for many subjects across the curriculum, perhaps more so on tasks that involve time pressure and sets high demands on working memory. Brady et al. (2018) also suggests that the intervention is not limited to academic settings, stating that it can be applicable and beneficial to other everyday situations (e.g. speaking at a meeting). Studies outside of academic settings have tested the arousal reappraisal intervention on evaluative situations with public speaking tasks and found it beneficial as well (Beltzer et al., 2014; Jamieson et al., 2013a).

6.2. Who Benefits From the Arousal Reappraisal Intervention?

No past research that has examined whether some people benefit more from the arousal reappraisal intervention than others. However, Brady et al. (2018) suggest that it could be more beneficial for first-year college students compared with upper-year college students. Because first-year college students report higher levels of anxiety (both in terms of emotionality and worry) and have less knowledge about how to perform well on upcoming exams, therefore being more willing to take all the help they can get. Brady et al. (2018) found that the arousal reappraisal intervention only benefited first-year students by decreasing their worry and increasing their performance on the exam and the overall course grade, this was not found for the upper-year students. The authors suggest that perhaps the arousal reappraisal intervention is most effective for the first- year students because the transition to college can be a sensitive period, making the students more receptive for the intervention. Moreover, Brady et al. (2018) suggest that other groups of students that might also be more vulnerable and as such could benefit from the arousal reappraisal intervention are: first-generation students, students who are learning English and students from underrepresented racial-ethnic minority backgrounds. Important to note however, Brady and

colleagues study despite having many participants still only received small differences between the reappraisal group and the control group.

Jamieson et al. (2016) found the arousal reappraisal intervention beneficial for poor-performing students, arguing that perhaps the intervention could benefit the poor-performing students to a higher extent compared to already high achieving students. Furthermore, also students with math anxiety could potentially benefit, although more studies are needed for that to be confirmed.

Patients suffering from social anxiety disorder benefited from the arousal reappraisal intervention. They are the first group of individuals with mental disorders that the intervention has been tested on, much because of their high levels of anxiety (Beltzer et al., 2014; Jamieson et al., 2013a).

According to Jamieson et al. (2018a), the arousal reappraisal intervention may be moderated by different beliefs. They speculate that individuals who believe that emotions are fixed may not even engage in the intervention and as such would not reap the benefits, whereas those with malleable beliefs would.

6.2.1. Could the arousal reappraisal intervention backfire? Brady and colleagues (2018) found that upper-year students in the reappraisal condition increased their emotionality and speculate as to why. It could be due to the intervention communicating that it is normal to feel anxious (creating a motivation to align with the norm) or that the reported emotionality is an aspiration to help their performance. In this case were the student's performance and worry not affected by their increased emotionality. However, it could be a risk, in some circumstances, to draw a student's attention toward their anxiety, especially for those who would otherwise experience relatively low levels of anxiety.

6.3. Long- term Effect of the Arousal Reappraisal Intervention

Despite the low number of studies on the arousal reappraisal intervention there are two studies that suggest that it could possibly have more than just a short-term effect. Jamieson et al. (2010) found that participants in the reappraisal condition scored higher on both the practice GRE test (in the laboratory) as well as on the actual GRE test 1-3 months later, with significant results showing a large effect size. However, that study could not completely state the long-term effect because only half their sample (30 students) obtained long-term data. Jamieson's and colleague's study (2016), tested the more extensive version of the arousal reappraisal intervention in a real-life classroom and did *not* receive significant result, the reappraisal condition had marginally higher final course grade compared to controls. Brady et al. (2018) investigated the intervention's long-term effect and found that the first-year student in the reappraisal condition received higher final course grade, note however that the effect size was small despite having many participants. Nevertheless, with great caution, we can say that the arousal reappraisal intervention may *possibly* have a long-term effect, providing students with increased performance.

If the arousal reappraisal intervention is showing a long-term effect, then what can explain those results? Yeager and Walton (2011) state that social-psychological interventions have lasting effects not because they are quick fixes to complicated problems but because they target student's subjective experiences in school; their thoughts, feelings and beliefs. The interventions also convey psychological ideas and taps into recursive processes that are present in educational environments. Academic anxiety and the poor performance that follows can produce a negative cycle, one that continues to feed off each other. This negative cycle can become even worse and stronger as time goes by. According to Cohen, Garcia, Apfel, and Master (2006) anything that disrupts that cycle can possibly bring long-term effect. A small reduction in anxiety can set off another recursive cycle that results in a slight

improvement in subsequent performance and can lead to improving performance over time. It is important to be aware that what appears to be a small and brief event in isolation may, in reality, be the final, or one factor out of many, that sets the process in motion. Another aspect to consider: to simply compare final course grade between the reappraisal condition and the control group raises the opportunity for many confounding variables to at least partially impact the results. Jamieson et al. (2016) states that long-term data could be explained by the students being more engaged with the material, improving test preparation processes, thus improving long-term performance. To date, it is not possible to completely confirm the long term effect of the arousal reappraisal intervention.

6.4. Criticism

Jamieson and colleagues have received some criticism for their arousal reappraisal intervention. Tamir (2018) is saying that the intervention is not targeting emotion regulation since there is no measure of affect (positive or negative) and that the goal of the reappraisal is not to eliminate or decrease the heightened arousal. Tamir (2018) suggests that the intervention rather targets motivation and gives two possible explanations; the first explanation is that the reappraisal intervention may actually modify *beliefs*. Believing in the benefits of stress changes the *motivation* to regulate it. When people have the expectancy that stress will be beneficial they won't try to avoid the stress and the likelihood of approaching it will increase. The second possibility is that these expectancies are *self-fulfilling*, expecting stress to be beneficial for performance could increase self-efficacy (confidence in one's abilities), promote goal resistance and therefore improve performance. Both explanations suggest that the arousal reappraisal intervention is targeting motivation and not emotion regulation. However, it is possible that the arousal reappraisal intervention does not have to be targeting one or the other but rather targets both due to the complexity of cognition and how it affects performance. Tamir (2018) ends with emphasizing that Jamieson and colleague's

findings open up to different interpretations and that it is necessary to identify the underlying mechanisms for the arousal reappraisal, such as factors that are likely to influence it.

Jamieson, Hangen, Lee, and Yeager (2018b) replies to the criticism and points to the BPS model of challenge and threat. They explain that based on the model, the arousal reappraisal intervention is indeed classified as a regulatory approach, where the resource vs demand appraisals interacts and determine affective responses, physiological responses, motivation and behavior. They are also emphasizing that for research on emotion challenge and threat are conceptualized as affective states.

For Tamir's (2018) argument regarding expectancies is according to Jamieson et al. (2018b) unlikely. The arousal reappraisal intervention has been tested against a placebo control group; results showing that both groups had rated the materials as similarly effective. But Jamieson et al. (2018b) add that future studies should investigate their relation and perhaps disentangle self-fulfilling prophecy and reappraisal processes.

In conclusion, Jamieson et al. (2018b) argues that the arousal reappraisal intervention is targeting emotion regulation and that it has the opportunity to not only inform, but also be informed by the broader emotion regulation literature.

6.5. Practical Implications

Brady et al. (2018) emphasize, since their study is only the second study (the other one is Jamieson et al., 2016) that has investigated the intervention in a classroom context, is it important to be cautious when giving recommendations. With that said, some suggestions can be made.

The arousal reappraisal intervention could be given at more "sensitive" stages in a student's life, when transitioning to certain grades, such as Brady et al. (2018) suggested when students are transitioning to college.

The arousal reappraisal intervention seems to reduce math anxiety and help low-achieving students perform better (Jamieson et al., 2016). According to Hembree (1991) successful experiences in math can help reduce the math anxiety. This means that if the arousal reappraisal intervention helps a student with their anxiety in such a way that the anxiety does not interfere with performance, then the intervention has the opportunity to break the vicious cycle, creating new and successful experiences in math.

Previous studies have found that successful emotion regulation is in part determined by the belief of emotion regulation success (Bigman et al., 2016). Since different types of emotion beliefs seem to impact emotion regulation, could it perhaps be useful for teachers to educate students about beliefs. Believing that emotions are malleable (De Castella et al., 2013; Kneland et al., 2016; Tamir et al., 2007), and that anxiety must not be considered a bad emotion, even though it is perceived as unpleasant (Ford & Gross, 2019). Gutentag and colleagues (2017) put it nicely; successful emotion regulation requires both conviction and skill.

According to Brady and colleagues (2018) teachers are playing an important role in how students address anxiety in the classroom. Teachers that advise students to calm down when experiencing anxiety as an attempt to reduce it, might actually be part of cultivating the belief that feelings of anxiety will hurt performance and creates a risk that the belief in and out of itself could lead to poor performance. Instead of cultivating this belief that anxiety should be avoided, more effective would be for teachers to discuss with their students how anxiety works and how it can actually lead to better performance. This discussion is true not only for exam situations but also for other anxiety-provoking situations at school.

The arousal reappraisal intervention is not a treatment for anxiety but rather merely an alternative way of coping with anxiety (Jamieson et al., 2018a). It should be viewed

as a compliment and not replace other evidence-based strategies like anxiety reduction techniques (Brady et al., 2018).

As Jamieson et al. (2018b) states, it is of great importance to remember that the arousal reappraisal intervention is by no means a “silver bullet”, it does not bring a comprehensive and immediate solution to the problem and nor should the strategy be expected to have a positive impact on all individuals. It is not a "one size fits all" intervention, this is important for teachers to keep in mind.

6.6. Limitations and Future Directions

The single most important limitation to highlight is the fact that there are not enough studies on the arousal reappraisal intervention, making it is difficult to draw any definite conclusions about its effect, both short and long-term.

The use of explicit self-reports, where participant answer questions like “I view this math test as a positive challenge” (Jamieson et al., 2016, p.585) when assessing resource vs demand appraisals, can be problematic. Because people process information and regulate their emotions sometimes unconsciously and automatically. Hence there is a risk that the explicit self-reports do not reflect the true matter (Jamieson et al., 2018a). That is why it is important to use implicit measurements which are less susceptible to social desirability. Social desirability bias is the tendency of participants answering questions in a way that they think others will view favorably (Gawronski, LeBel, & Peters, 2007).

One limitation of Brady et al. (2018) study that is important to consider, is that measures of emotionality and worry were reported *after* the exam was completed. This raises the risk of student’s subjective sense of their performance influencing their reported emotionality and worry. Future research should examine if similar results are obtained when the measures are collected *before* the exam. In addition there were only one question regarding emotionality and it didn’t specifically ask about bodily sensations of physiological

arousal. The measure of worry was also lacking specificity, with only two questions. Future studies should measure emotionality and worry more extensively, with far more questions addressing different aspects of each.

Future studies should also investigate different aspects of individual differences and how they can impact the effectiveness of the arousal reappraisal intervention (Jamieson et al., 2013b). For example, Mauss, Cook, Cheng, and Gross (2007) found that individuals who more often used reappraisal (high reappraisal tendencies) were better at applying reappraisal instructions compared to individuals with low reappraisal tendencies. Moreover, Jamieson et al. (2018b) suggests that an individual's introspective ability could also affect the arousal reappraisal intervention. Introspective ability is how well an individual perceives internal visceral states. One study found that introspective awareness facilitated reappraisal, thus greater levels of introspective awareness were associated with more successful reappraisal (Füstös, Gramann, Herbert, & Pollatos, 2012). Furthermore, the majority of studies have demonstrating the effect of the arousal reappraisal intervention been on healthy individuals. Only a few have tested it on individuals suffering from Social Anxiety Disorder (Beltzer et al., 2014; Jamieson et al., 2013a). A classroom is a place filled with students, all with different prerequisites and abilities, some healthy and some not, it is therefore important for future studies to investigate if the intervention might work as effectively on students suffering from mental disorders. Research is suggesting that individuals suffering from psychological disorders tend to have it more difficulty in regulating their emotions, compared to healthy individuals (Aldao, Nolen-Hoeksema, & Schweizer, 2010). Also, would some groups of individuals gain more from the intervention than others? For example, would women benefit more than men, considering that many studies show that women experience greater levels of anxiety (e.g. Brady et al., 2018). However, it does not have to be so, since women generally tend to outperform men despite their greater levels of anxiety (Voyer & Voyer, 2014).

It is important to consider the design of the studies. Controlled experiments provide the best opportunities to study causality. Experiments conducted in a laboratory can assess the basic mechanisms of mood and human emotions and field experiments can monitor how effective an educational intervention can be. However, laboratory experiments on emotions are often restricted by ethical factors and have problems with ecological validity. Ecological validity is the degree of generalizability, meaning how well the findings in a laboratory setting can translate into a real-life setting. Real-life settings are complex, context-bound and students can sometimes experience very intense emotions, aspects that an artificial laboratory setting has difficulty to mimic. Thus, one problematic aspect of laboratory experiments is that they are (to some extent) artificial, not representing real-life situations and can, therefore, demonstrate causality that is not found in the real-life setting (Pekrun, 2006). That is why future studies need to investigate the arousal reappraisal intervention in real-life classrooms as much as possible. To date, there are only two studies that have done that (Brady et al., 2018; Jamieson et al., 2016). Moreover, real-life studies can reveal how the intervention will be received by the students will some ignore it or even resist it, and will it be ineffective or even backfire? (Brady et al., 2018).

I personally think that once the intervention has received more empirical support, future studies should investigate more specifically how the arousal reappraisal intervention should be introduced to the students in a real-life classroom. Brady et al. (2018) gave it in an email the night before the exam and Jamieson et al. (2010) delivered it on the exam-day just minutes before. Is it enough for students to read the reappraisal message or should the teacher talk more openly about reappraisal during class so that a greater understanding of emotion regulation and its effect on performance is taught to the students? Should teachers perhaps verbally remind students about its effects during different types of high-pressure situations? Another personal thought of mine, to date, there are two types of the

arousal reappraisal intervention: (1) A ~10-min reading exercise comprised of summaries of scientific articles on the adaptive benefits of stress responses and (2) a short, single-paragraph instruction. Both have been tested and seem to produce promising results, however, one can wonder how the short paragraph can give similar results as the more effortful 10-minute reading exercise (see Appendix A and B for excerpts of the intervention materials). I would imagine that the 10 min reading exercise would be more effective in manifesting the purpose of the intervention. Future studies should test both types of the arousal reappraisal interventions, to see if there are differences both short and long-term. Teachers need to know how to convey the knowledge in such a way that as many students as possible can reap the benefits.

Future research must study moderators; it will help specify the conditions necessary for reappraisal effects to manifest themselves and at the same time highlight limitations. Jamieson et al. (2013b) suggest that one such moderator is motivation.

The arousal reappraisal intervention has only been tested once on math anxiety (Jamieson et al., 2016) and no studies has, so far, specifically tested it on test anxiety (Brady et al., 2018). Future studies should investigate how the intervention impacts math and test anxious students (Foley et al., 2017).

The evidence on the arousal reappraisal intervention is far from complete, in addition to what's been mentioned, should its generalizability and long-term effect more thoroughly be investigated (Jamieson et al., 2018a). Jamieson et al. (2016) suggests that future studies should explore more fully the long-term effect by making students daily write in journals. Writing down what they are doing, is one way of mapping out what is causing the improved long-term performance (Jamieson et al., 2016).

7. Conclusion

According to Brady et al. (2018), is it a possibility that students can internalize the arousal reappraisal intervention and change their default interpretation of anxiety from negative, to neutral or even beneficial. As such what started as a reappraisal can over the course of time simply become an appraisal (Gross, 2015). The arousal reappraisal intervention *might* work in terms of producing good performance, reducing worry and academic anxiety, both short and long-term. The intervention shows promise but if the arousal reappraisal intervention can bear the test of time is for future studies to determine. My hope is that beyond simply advancing our theoretical knowledge that the findings provided by this thesis will contribute to the broader efforts aimed at developing strategies to cope with the deleterious effects of academic anxiety on performance and maybe even foster a new way of looking at anxiety. As emphasized by PISA “Schools are not only places where students acquire academic skills; they are also social environments where children can develop the social and emotional competencies that they need to thrive” (OECD, 2016, p.4).

8. References

Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, *30*(2), 217-237.doi.org/10.1016/j.cpr.2009.11.004

Alter, A. L., Aronson, J., Darley, J. M., Rodriguez, C., & Ruble, D. N. (2010). Rising to the threat: Reducing stereotype threat by reframing the threat as a challenge. *Journal of Experimental Social Psychology*, *46*(1), 166-171.doi.org/10.1016/j.jesp.2009.09.014

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*(5), 181-185. doi:10.1111/1467-8721.00196

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General*, *130*(2), 224.doi: 10.1037//0096-3445.130.2.224

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review*, *14*(2), 243-248.doi:10.3758/BF03194059.

Baddeley, A. D., & Logie, R. H. (1999). Working memory: The multiple-component model. *Models of Working Memory*, 28-61. doi:10.1017/cbo9781139174909.005

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: a meta-analytic study. *Psychological Bulletin*, *133*(1), 1.doi:10.1037/0033-2909.133.1.1

Beilock, S. L. (2008). Math performance in stressful situations. *Current Directions in Psychological Science*, *17*(5), 339-343. doi:10.1111/j.1467-8721.2008.00602.x

Beilock, S. L., & DeCaro, M. S. (2007). From poor performance to success under stress: Working memory, strategy selection, and mathematical problem solving under pressure. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*(6), 983. doi:10.1037/0278-7393.33.6.983

Beilock, S.L., Schaeffer, M.W., & Rozek, C.S. (2017). Understanding and Addressing Performance Anxiety. In Elliot, A. J., Dweck, C. S., & Yeager, D. S. (Eds.).*Handbook of competence and motivation: theory and application* (pp.175- 191). New York: Guilford Publications.

Beltzer, M. L., Nock, M. K., Peters, B. J., & Jamieson, J. P. (2014). Rethinking butterflies: The affective, physiological, and performance effects of reappraising arousal during social evaluation. *Emotion*, *14*(4), 761. doi: 10.1037/a0036326

Bigman, Y. E., Mauss, I. B., Gross, J. J., & Tamir, M. (2016). Yes I can: Expected success promotes actual success in emotion regulation. *Cognition and Emotion*, *30*(7), 1380-1387. doi:10.1080/02699931.2015.1067188

Bishop, S. J. (2007). Neurocognitive mechanisms of anxiety: an integrative account. *Trends in Cognitive Sciences*, *11*(7), 307-316.doi:10.1016/j.tics.2007.05.008

Blascovich, J. (1992). A biopsychosocial approach to arousal regulation. *Journal of Social and Clinical Psychology*, *11*(3), 213-237. doi:10.1521/jscp.1992.11.3.213

Bradley, R. T., McCraty, R., Atkinson, M., Tomasino, D., Daugherty, A., & Arguelles, L. (2010). Emotion self-regulation, psychophysiological coherence, and test anxiety: results from an experiment using electrophysiological measures. *Applied Psychophysiology and Biofeedback*, *35*(4), 261-283.doi:10.1007/s10484-010-9134-x

Brady, S. T., Hard, B. M., & Gross, J. J. (2018). Reappraising test anxiety increases academic performance of first-year college students. *Journal of Educational Psychology*, *110*(3), 395. doi.org/10.1037/edu0000219

Brooks, A. W. (2014). Get excited: Reappraising pre-performance anxiety as excitement. *Journal of Experimental Psychology: General*, *143*(3), 1144. doi:10.1037/a0035325.

Buhle, J. T., Silvers, J. A., Wager, T. D., Lopez, R., Onyemekwu, C., Kober, H., ... & Ochsner, K. N. (2014). Cognitive reappraisal of emotion: a meta-analysis of human neuroimaging studies. *Cerebral Cortex*, *24*(11), 2981-2990. doi.org/10.1093/cercor/bht154

Cassady, J. C. (2001). The stability of undergraduate students' cognitive test anxiety levels. *Practical Assessment, Research & Evaluation*, *7*(20), 1-8.

Cassady, J. C. (2010). *Anxiety in schools: the causes, consequences, and solutions for academic anxieties* (Vol. 2). Peter Lang. doi:10.1037/h0062855

Cassady, J. C., & Johnson, R. E. (2002). Cognitive test anxiety and academic performance. *Contemporary Educational Psychology*, *27*(2), 270-295. doi:10.1006/ceps.2001.1094,

Cohen, G. L., Garcia, J., Apfel, N., & Master, A. (2006). Reducing the racial achievement gap: A social-psychological intervention. *Science*, *313*(5791), 1307-1310. doi:10.1126/science.1128317

Crum, A. J., Salovey, P., & Achor, S. (2013). Rethinking stress: The role of mindsets in determining the stress response. *Journal of Personality and Social Psychology*, *104*(4), 716. doi:10.1037/a0031201

De Castella, K., Goldin, P., Jazaieri, H., Ziv, M., Dweck, C. S., & Gross, J. J. (2013). Beliefs about emotion: Links to emotion regulation, well-being, and psychological distress. *Basic and Applied Social Psychology*, *35*(6), 497-505.doi:10.1080/01973533.2013.840632

Derakshan, N., & Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance: New developments from attentional control theory. *European Psychologist*, *14*(2), 168-176. doi:10.1027/1016-9040.14.2.168

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, *11*(1), 19-23. doi:10.1111/1467-8721.00160

Etkin, A., Egner, T., & Kalisch, R. (2011). Emotional processing in anterior cingulate and medial prefrontal cortex. *Trends in Cognitive Sciences*, *15*(2), 85-93. doi:10.1016/j.tics.2010.11.004

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition & Emotion*, *6*(6), 409-434.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion*, *7*(2), 336. doi:10.1037/1528-3542.7.2.336

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current Directions in Psychological Science*, *26*(1), 52-58.doi: 10.1177/0963721416672463

Folkman, S., Lazarus, R. S., Gruen, R. J., & DeLongis, A. (1986). Appraisal, coping, health status, and psychological symptoms. *Journal of Personality and Social Psychology*, *50*(3), 571.doi.org/10.1037/0022-3514.50.3.571

Ford, B. Q., & Gross, J. J. (2019). Why beliefs about emotion matter: An emotion-regulation perspective. *Current Directions in Psychological Science*, *28*(1), 74-81.doi: 10.1177/0963721418806697

Füstös, J., Gramann, K., Herbert, B. M., & Pollatos, O. (2012). On the embodiment of emotion regulation: interoceptive awareness facilitates reappraisal. *Social Cognitive and Affective Neuroscience*, *8*(8), 911-917. doi:10.1093/scan/nss089

Gawronski, B., LeBel, E. P., & Peters, K. R. (2007). What do implicit measures tell us?: Scrutinizing the validity of three common assumptions. *Perspectives on Psychological Science*, *2*(2), 181-193. doi.org/10.1111/j.1745-6916.2007.00036.x

Gazzaniga, M., & Ivry, R. B. (2013). *Cognitive neuroscience: the biology of the mind: fourth international student edition*. WW Norton.

Gross, J. J. (1998a). Antecedent-and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology*, *74*(1), 224. doi: 10.1037/0022-3514.74.1.224

Gross, J. J. (1998b). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, *2*(3), 271-299. doi:10.1037/1089-2680.2.3.271

Gross, J. J. (2015). The extended process model of emotion regulation: Elaborations, applications, and future directions. *Psychological Inquiry*, *26*(1), 130-137. doi: 10.1080/1047840X.2015.989751

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, *85*(2), 348-362. doi.org/10.1037/0022-3514.85.2.348

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

Grover, R. L., Ginsburg, G. S., & Ialongo, N. (2007). Psychosocial outcomes of anxious first graders: A seven-year follow-up. *Depression and Anxiety*, *24*(6), 410-420. doi: 10.1002/da.20241

Gutentag, T., Halperin, E., Porat, R., Bigman, Y. E., & Tamir, M. (2017). Successful emotion regulation requires both conviction and skill: beliefs about the controllability of emotions, reappraisal, and regulation success. *Cognition and Emotion*, *31*(6), 1225-1233. doi.org/10.1080/02699931.2016.1213704

Harley, J. M., Pekrun, R., Taxer, J. L., & Gross, J. J. (2019). Emotion regulation in achievement situations: An integrated model. *Educational Psychologist*, *54*(2), 106-126. doi:10.1080/00461520.2019.1587297

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, 33-46. doi:10.2307/749455

Hofmann, S. G., Asnaani, A., Vonk, I. J., Sawyer, A. T., & Fang, A. (2012). The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and Research, 36*(5), 427-440. doi:10.1007/s10608-012-9476-1

Hofmann, S. G., Heering, S., Sawyer, A. T., & Asnaani, A. (2009). How to handle anxiety: The effects of reappraisal, acceptance, and suppression strategies on anxious arousal. *Behaviour Research and Therapy*, *47*(5), 389-394. doi: 10.1016/j.brat.2009.02.010

Huberty, T. J. (2009). Test and performance anxiety. *Principal Leadership, 10*(1), 12-16.

Ilkowska, M., & Engle, R. W. (2010). Trait and state differences in working memory capacity. In *Handbook of individual differences in cognition* (pp. 295-320). Springer, New York, NY.

Jamieson, J.P. (2017). Challenge and threat appraisals. In Elliot, A. J., Dweck, C. S., & Yeager, D. S. (Eds.).*Handbook of competence and motivation: theory and application* (pp.175- 191). New York: Guilford Publications.

Jamieson, J. P., Hangen, E. J., Lee, H. Y., & Yeager, D. S. (2018a). Capitalizing on appraisal processes to improve affective responses to social stress. *Emotion Review, 10*(1), 30-39. doi.org/10.1177/1754073917693085

Jamieson, J. P., Hangen, E. J., Lee, H. Y., & Yeager, D. S. (2018b). Author Reply: Arousal Reappraisal as an Affect Regulation Strategy. *Emotion Review, 10*(1), 74-76. doi.org/10.1177/1754073917724878

Jamieson, J. P., Mendes, W. B., Blackstock, E., & Schmader, T. (2010). Turning the knots in your stomach into bows: Reappraising arousal improves performance on the GRE. *Journal of Experimental Social Psychology*, *46*(1), 208-212. doi.org/10.1016/j.jesp.2009.08.015

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2013a). Changing the conceptualization of stress in Social Anxiety Disorder: Affective and physiological consequences. *Clinical Psychological Science,*1, 363–374. doi:10.1177/2167702613482119

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2013b). Improving acute stress responses: The power of reappraisal. *Current Directions in Psychological Science*, 22, 51–56. doi:10.1177/0963721412461500

Jamieson, J. P., Nock, M. K., & Mendes, W. B. (2012). Mind over matter: Reappraising arousal improves cardiovascular and cognitive responses to stress. *Journal of Experimental Psychology: General, 141*(3), 417. doi: 10.1037/a0025719

Jamieson, J. P., Peters, B. J., Greenwood, E. J., & Altose, A. J. (2016). Reappraising stress arousal improves performance and reduces evaluation anxiety in classroom exam situations. *Social Psychological and Personality Science*, *7*(6), 579-587. doi:10.1177/1948550616644656

John-Henderson, N. A., Rheinschmidt, M. L., & Mendoza-Denton, R. (2015). Cytokine responses and math performance: The role of stereotype threat and anxiety reappraisals. *Journal of Experimental Social Psychology*, *56*, 203-206. doi:10.1016/j.jesp.2014.10.002

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General*, *137*(4), 691. doi:10.1037/a0013834

Killu, K., Marc, R., & Crundwell, A. (2016). Students with anxiety in the classroom: Educational accommodations and interventions. *Beyond Behavior*, *25*(2), 30-40. doi:10.1177/107429561602500205

Klein, K., & Boals, A. (2001). Expressive writing can increase working memory capacity. *Journal of Experimental Psychology: General*, *130*(3), doi:10.1037/0096-3445.130.3.520

Kohn, N., Eickhoff, S. B., Scheller, M., Laird, A. R., Fox, P. T., & Habel, U. (2014). Neural network of cognitive emotion regulation—an ALE meta-analysis and MACM analysis. *Neuroimage*, *87*, 345-355. doi:10.1016/j.neuroimage.2013.11.001

Kneeland, E. T., Nolen-Hoeksema, S., Dovidio, J. F., & Gruber, J. (2016). Emotion malleability beliefs influence the spontaneous regulation of social anxiety. *Cognitive Therapy and Research*, *40*(4), 496-509. doi:10.1007/s10608-016-9765-1

Lazarus, R. S. (1991). Progress on a cognitive-motivational-relational theory of emotion. *American Psychologist*, *46*(8), 819.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer publishing company.

LeDoux, J. (2007). The amygdala. *Current Biology, 17*(20), R868-R874.

Liebert, R. M., & Morris, L. W. (1967). Cognitive and emotional components of test anxiety: A distinction and some initial data. *Psychological Reports, 20*(3), 975-978. doi:10.2466/pr0.1967.20.3.975

Lyons, I. M., & Beilock, S. L. (2012). When math hurts: math anxiety predicts pain network activation in anticipation of doing math. *PloS one, 7*(10), e48076. doi:10.1371/journal.pone.0048076

Maloney, E. A., & Beilock, S. L. (2012). Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences, 16*(8), 404-406. doi:10.1016/j.tics.2012.06.008

Maloney, E. A., Sattizahn, J. R., & Beilock, S. L. (2014). Anxiety and cognition. *Wiley Interdisciplinary Reviews: Cognitive Science, 5*(4), 403-411. doi: 10.1002/wcs.1299

Mattarella-Micke, A., Mateo, J., Kozak, M. N., Foster, K., & Beilock, S. L. (2011). Choke or thrive? The relation between salivary cortisol and math performance depends on individual differences in working memory and math-anxiety. *Emotion, 11*(4), 1000. doi:10.1037/a0023224

Mauss, I. B., Cook, C. L., Cheng, J. Y., & Gross, J. J. (2007). Individual differences in cognitive reappraisal: Experiential and physiological responses to an anger provocation. *International Journal of Psychophysiology, 66*(2), 116-124. doi.org/10.1016/j.ijpsycho.2007.03.017

Mazzone, L., Ducci, F., Scoto, M. C., Passaniti, E., D'Arrigo, V. G., & Vitiello, B. (2007). The role of anxiety symptoms in school performance in a community sample of children and adolescents. *BMC Public Health, 7*(1), 347.doi: 10.1186/1471-2458-7-347

McDonald, A. S. (2001). The prevalence and effects of test anxiety in school children. *Educational Psychology*, *21*(1), 89-101.doi:10.1080/01443410020019867

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49-100. doi:10.1006/cogp.1999.0734

Moore, L. J., Vine, S. J., Wilson, M. R., & Freeman, P. (2015). Reappraising threat: How to optimize performance under pressure. *Journal of Sport and Exercise Psychology*, *37*(3), 339-343. doi:10.1123/jsep.2014-0186

Morrison, J. (2014). *DSM-5 made easy: The clinician's guide to diagnosis*. Guilford Publications.

O'Brien, L. T., & Crandall, C. S. (2003). Stereotype threat and arousal: Effects on women's math performance. *Personality and Social Psychology Bulletin*, *29*(6), 782-789. doi:10.1177/0146167203029006010

OECD (2016), *PISA 2015 Results (Volume II): Policies and Practices for Successful Schools*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264267510-en.

OECD (2013), *PISA 2012 Results: Ready to Learn (Volume III): Students' Engagement, Drive and Self-Beliefs*, PISA, OECD Publishing, Paris, https://doi.org/10.1787/9789264201170-en.

Ochsner, K. N., & Gross, J. J. (2008). Cognitive emotion regulation: Insights from social cognitive and affective neuroscience. *Current Directions in Psychological Science*, *17*(2), 153-158. doi.org/10.1111/j.1467-8721.2008.00566.x

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. (2002). Rethinking feelings: an FMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience*, *14*(8), 1215-1229. doi:10.1162/089892902760807212

Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D., & Gross, J. J. (2004). For better or for worse: neural systems supporting the cognitive down-and up-regulation of negative emotion. *Neuroimage*, *23*(2), 483-499. doi:10.1016/j.neuroimage.2004.06.030

Ochsner, K. N., Silvers, J. A., & Buhle, J. T. (2012). Functional imaging studies of emotion regulation: a synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences*, *1251*, E1.doi: 10.1111/j.1749-6632.2012.06751.x

Owens, M., Stevenson, J., Hadwin, J. A., & Norgate, R. (2014). When does anxiety help or hinder cognitive test performance? The role of working memory capacity. *British Journal of Psychology*, *105*(1), 92-101. doi:10.1111/bjop.12009

Owens, M., Stevenson, J., Hadwin, J. A., & Norgate, R. (2012). Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory. *School Psychology International*, *33*(4), 433-449. doi: 10.1177/0143034311427433

Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, *18*(4), 315-341.doi:10.1007/s10648-006-9029-9

Putwain, D. W., Woods, K. A., & Symes, W. (2010). Personal and situational predictors of test anxiety of students in post-compulsory education. *British Journal of Educational Psychology*, *80*(1), 137-160. doi:10.1348/000709909X466082

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and*

Development, *14*(2), 187-202. doi:10.1080/15248372.2012.664593

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance in the classroom. *Science*, *331*(6014), 211-213. doi:10.1126/science.1199427

van Reekum, C. M., Johnstone, T., Urry, H. L., Thurow, M. E., Schaefer, H. S., Alexander, A. L., & Davidson, R. J. (2007). Gaze fixations predict brain activation during the voluntary regulation of picture-induced negative affect. *Neuroimage*, *36*(3), 1041-1055. doi:10.1016/j.neuroimage.2007.03.052

Sammy, N., Anstiss, P. A., Moore, L. J., Freeman, P., Wilson, M. R., & Vine, S. J. (2017). The effects of arousal reappraisal on stress responses, performance and attention. *Anxiety, Stress, & Coping*, *30*(6), 619-629. doi:10.1080/10615806.2017.1330952

Sarason, I. G. (1988). Anxiety, self-preoccupation and attention. *Anxiety Research*, *1*(1), 3-7. doi:10.1080/10615808808248215

Schwarzer, R. (1980). Worry and emotionality as separate components in test anxiety. *Applied Psychology*, *33*(2), 205-220. doi:10.1111/j.1464-0597.1984.tb01429.x

Siemer, M., Mauss, I., & Gross, J. J. (2007). Same situation--different emotions: how appraisals shape our emotions. *Emotion*, *7*(3), 592. doi:10.1037/1528-3542.7.3.592

Silvers, J. A., Buhle, J. T., Ochsner, K. N., & Silvers, J. (2013). The neuroscience of emotion regulation: Basic mechanisms and their role in development, aging and psychopathology. *The handbook of cognitive neuroscience*, *1*, 52-78.

Silvers, J. A., Weber, J., Wager, T. D., & Ochsner, K. N. (2014). Bad and worse: neural systems underlying reappraisal of high-and low-intensity negative emotions. *Social Cognitive and Affective Neuroscience*, *10*(2), 172-179. doi:10.1093/scan/nsu043

Skinner, N., & Brewer, N. (2002). The dynamics of threat and challenge appraisals prior to stressful achievement events. *Journal of Personality and Social Psychology*, *83*(3), 678..doi.org/10.1037/0022-3514.83.3.678

Smith, C. A., & Kirby, L. D. (2009). Putting appraisal in context: Toward a relational model of appraisal and emotion. *Cognition and Emotion*, *23*(7), 1352-1372. doi:10.1080/02699930902860386

Social Stress Lab Research. (2016) Retrieved from https://socialstresslab.wixsite.com/urochester/research (Appendix A & B)

Tamir, M. (2018). Comment on Jamieson, Hangen, Lee, and Yaeager: What Should We Regulate to Promote Adaptive Functioning and How? *Emotion Review*, *10*(1), 65-67. doi:10.1177/1754073917719328

Tamir, M., John, O. P., Srivastava, S., & Gross, J. J. (2007). Implicit theories of emotion: Affective and social outcomes across a major life transition. *Journal of Personality and Social Psychology*, *92*(4), 731. doi:10.1037/0022-3514.92.4.731

Ulrich-Lai, Y. M., & Herman, J. P. (2009). Neural regulation of endocrine and autonomic stress responses. *Nature Reviews Neuroscience*, *10*(6), 397. doi:10.1038/nrn2647

Voyer, D., & Voyer, S. D. (2014). Gender differences in scholastic achievement: A meta-analysis. *Psychological Bulletin*, *140*(4), 1174. doi:10.1037/a0036620

Wager, T. D., Davidson, M. L., Hughes, B. L., Lindquist, M. A., & Ochsner, K. N. (2008). Prefrontal-subcortical pathways mediating successful emotion regulation. *Neuron*, *59*(6), 1037-1050. doi:10.1016/j.neuron.2008.09.006

Walton, G. M., & Spencer, S. J. (2009). Latent ability: Grades and test scores systematically underestimate the intellectual ability of negatively stereotyped students. *Psychological Science, 20*(9), 1132-1139. doi:10.1111/j.1467-9280.2009.02417.x

Weinberg, R. S., & Gould, D. (2011). *Foundations of sport and exercise psychology*. Champaign, Human Kinetics.

Yeager, D. S., & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research, 81*(2), 267-301.doi: 10.3102/0034654311405999

9.1. Appendix A: Parts of the intervention materials used in Jamieson et al., 2016

This excerpt is adapted from Nock et al.'s (2011) study that appeared in the *Journal of Clinical Psychology*

Stress is a normal reaction that helps you face the challenges in your life. It is not harmful. In fact, if we did not have stress reactions we could not survive. If stress is helpful, then why do most people see it as a negative experience?

Research indicates that negative reactions to stressful situations like taking an exam are the result of how we think about stress (also known as 'cognitive appraisals'). When the "*fight or flight"* system activates, our brain searches for possible sources of harm. However, in modern society there is often no physical threat. When no explanation can be found, the brain invents explanations such as, "There must be something wrong with me." Nothing could be further from the truth. Stress is adaptive and good.

During stressful situations remember that your body's responses are beneficial. Increased heart rate, sweating, and heavy breathing are all signs that your body is delivering oxygen (fuel for thinking) to your brain.

In your own words please briefly describe how this information can help you perform well on your exam today:

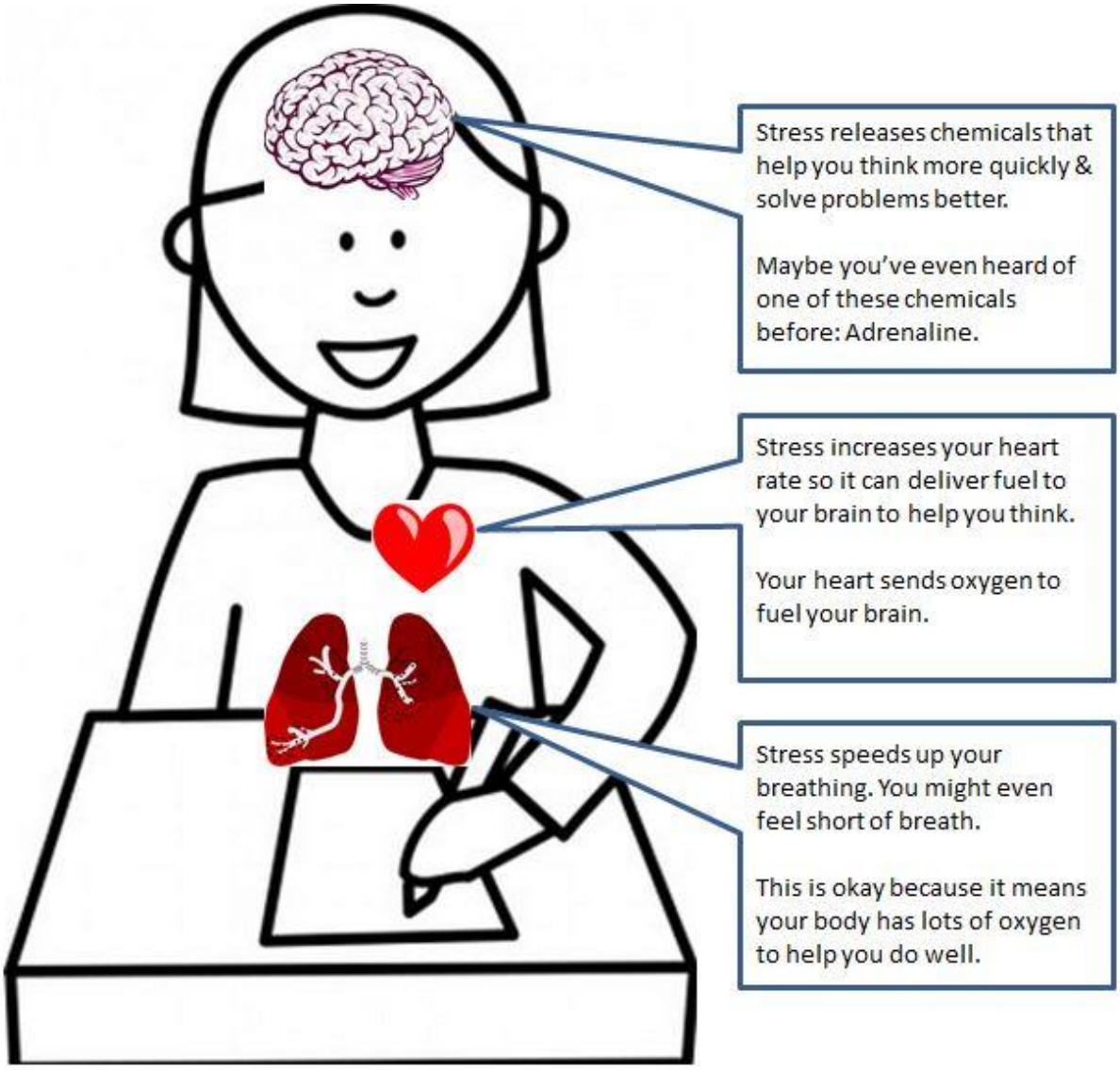
_____

_____

_____

_____

The following is an illustrative diagram that shows the biological changes that happen when we experience stress. Please take a minute to note where the changes occur and how these help us do well.



In your own words please briefly describe how this information can help you perform well on your exam today:

_____

_____

_____

_____

9.2. Appendix B: Parts of the intervention materials used in Jamieson et al., 2012

Screen 1:

Thank you for being a part of this experiment.

In the following, you will be given information about how our body's responses to stress help us to perform well. You will be presented with excerpts from four scientific journal articles. While you read each excerpt, we would like you to think about how your bodily reactions to stress help you to survive.

After each article you will answer some questions regarding the information that was presented to you.

Please let the experimenter know if you have any questions at this time.

Screen 2:

This excerpt is taken from Craske and Barlow's (2001) Clinical Handbook of Psychological Disorders:

Scientifically, stress is named the "fight-flight response" because its effects are aimed toward the organism's either fighting or fleeing from danger. Thus, the number one purpose of our stress response is to protect us. In today's hectic world, this response is a necessary mechanism.

For example, imagine if a person were crossing a busy intersection when a car suddenly sped toward him or her. If the person experienced no arousal, he or she would be hit. The purpose of this story is simple - stress & anxiety protect humans, it does not harm them. It is a survival mechanism. To experience anxiety in stressful situations means to be fit for survival.

Screen 3:

Question 1:

Stress is a human survival mechanism. True or False?

Screen 4:

Question 2:

Who experiences anxiety in stressful situations?

Options:
Only people with social anxiety disorder
Only people who perform poorly
Only people scared of public speaking
Everyone. To experience anxiety is to be fit for survival