An Experimental Replication and Refinement of the

Undoing Hypothesis of Positive Emotions

by

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ABSTRACT

Broaden and build theory (BBT; Fredrickson, 1998; 2001) postulates that positive emotions expand the scope of one's attention and thought-action repertoires (Fredrickson & Branigan, 2005). Within the boundaries of BBT, the undoing hypothesis (Fredrickson, 1998, Fredrickson & Levenson, 1998) argues that positive emotions themselves do not bring forth specific action tendencies or urges; therefore, they do not consequently require an increase in cardiovascular activity to carry out the urge. On the other hand, positive emotions have evolved to subdue the cardiovascular response previously initiated by negative emotions. This dissertation proposes that the real power of positive emotions might be to undo not the effects of negative emotions themselves, however, but simply reduce the arousal itself. This dissertation used minor physiological arousal (e.g., a step-stool task) to simulate the cardiovascular effects of the stress manipulations used in previous tests of the undoing hypothesis by Fredrickson and colleagues. This dissertation asks if positive emotions undo the cardiovascular reactivity of an emotionally neutral stimulus. Positive emotions were induced through one film clip (i.e., a happy film clip) and was compared to a neutral film clip (no emotion elicited). An experimental design measured the effects of arousal induction and film clip on participants' cardiovascular activity. Results indicated that positive emotions had the same effect as no emotions on participants' cardiovascular activity. Implications for theory and research are provided, as well as an assessment of the study's strengths and limitations. Finally, several directions for future research are offered.

DEDICATION

This dissertation is dedicated to Jesus Christ and Alexis Joy Valianos-Deiss, two people whose presence in my life I never want to be without.

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RATIONALE

Positive emotions often represent the most pleasant of human experiences. Among the experiences included when speaking of positive emotions, the following ones come to mind including: joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe, and love. On the other hand, negative emotions such as fear, anxiety, depression, doubt, embarrassment, and resentment usually involve these viscerally unpleasant experiences. Beyond the initial pleasant or unpleasant experiences, positive and negative emotions have consequential health implications as well.

Theory and research on positive emotions suggest many opportunities to enhance people's health by decreasing the deleterious effects of stress. As will be addressed later in this chapter with greater detail, negative emotions lead to stress, which leads to increased susceptibility to illness, higher morbidity, and decreased human functioning (Hadany, Beker, Eshel, & Feldman, 2006; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002; Segerstrom & Miller, 2004). The theoretical framework implicated by the discussion of positive emotions and stress is Fredrickson's broaden and build theory (BBT) with a specific focus on the undoing hypothesis of positive emotions (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000). This framework proposes that negative emotions (e.g., fear, anxiety) narrow the thoughts and behaviors that people are inclined to consider and positive emotions (e.g., happiness, contentment) are shown to broaden the number of thoughts people have and behaviors that people are inclined to consider. As will be explained subsequently, when negative emotions narrow a person's cognitions and behaviors to deal with some event, there are accompanying harmful effects that can occur in one's body.

When positive emotions broaden a person's cognitions and behaviors, Fredrickson (1998; 2003) argues that there is a subsequent undoing of the lingering effects of negative emotions. Unlike negative emotions, positive emotions broaden people's thought and action repertoires (what they think and want do in the moment); therefore, they may also uncork the hold that negative emotions possess on both mind and body. In addition, any preparing of the mind and body for specific action tendency is undone. When positive emotions broaden a person's thoughts and behaviors, they essentially reverse the narrowing of people's behaviors brought on by negative emotions. Fredrickson's (1998; 2000) argument is that positive emotions also reverse the physiological effects of negative emotions. Put simply, Fredrickson's undoing hypothesis argues that any cognitive effects of positive emotions are tied to specific and beneficial changes in cardiovascular reactivity.

This dissertation project will attempt to experimentally and approximately replicate the original study (Fredrickson et al., 2000) on the undoing hypothesis. This study will specifically address the undoing nature of positive emotions. Fredrickson's undoing hypothesis proposes that experiencing positive emotion creates a cognitive broadening which consequently undoes the physiological arousal from negative emotions—that is, it accelerates one's return to physiological baseline, facilitating recovery from stress. This dissertation proposes that the real power of positive emotions might be to undo not the effects of negative emotions themselves, however, but simply the arousal itself. In past studies of the undoing hypothesis (Fredrickson & Levenson, 1998; Fredrickson et al., 2000), stress was induced using either a film clip or a public speaking stressor. Those stimuli created the negative emotions of fear and anxiety. This dissertation project research will use light exercise and a public speaking task to simulate the physiological effects of the stress manipulation used in previous positive emotion studies.

If positive emotions undo the physiological effects of small amounts of exercise (an emotion-free condition) at the same rate as undoing the physiological effects of stress from negative emotions, the original undoing hypothesis will need to be refined to account for these outcomes. Further, regardless of the outcomes, the results will inform theory and research on the power of positive emotions in one of two ways. If positive emotions undo the physiological effects of negative emotions faster than undoing the physiological effects of the emotion neutral manipulation, it will bolster the explanatory power and empirical support for the undoing hypothesis of positive emotions. If however, positive emotions undo the physiological effects of arousal from negative emotions slower or at similar rates than the emotion-neutral situations, the original theoretical framework will need to be refined to explain how positive emotions undo arousal in general, not merely for arousal generated from negative emotions and stress.

The following section will begin with defining emotion; this will be followed by an articulation of what differentiates positive and negative emotions.

Afterward, Fredrickson's theory of positive emotions will be articulated as an explanation of what positive emotions are and what they do. Finally, the relevance of positive emotion to human health will be addressed.

What is Emotion?

Any discussion of the effects of positive emotions must first begin with defining emotions themselves as the term is often used in various situations, contexts, and references. Many scholarly disciplines will have its own way of arguing what constitutes an emotion. This dissertation is not attempting to state that emotion as described here is absolute or better than other definitions. However, it is important to conceptually define how it is that emotion will be approached in this study.

Some suggest that emotions occur when people experience some environmental stimulus, which subsequently results in an affective reaction (Guerrero & Andersen, 2000). Additionally, Fridja (1993) argues that emotion is your body's multidimensional response to any event that either enhances or inhibits one's goals. This response manifests in three areas including a cognitive appraisal, physiological reaction, and behavioral tendencies (Frijda, 1986; Scherer, 1994). Cognitive appraisal refers to an analysis of the objects and events included in the initial environmental stimulus that causes the emotion. Physiological reaction refers to activity by one's biological systems (e.g., increased cardiovascular activity). This increased activity helps individuals carry out the relevant behavioral tendencies such as the negative emotion-induced fight or flight response (e.g., physically fighting or swimming from an attacking shark).

In this dissertation, the physiological reaction is characterized by the term arousal. Specifically, arousal is defined as increases in physiological activity in the body's sympathetic nervous system including heart rate, blood pressure, blood sugar, respiratory rate, and pupil dilation (Bradley, Miccoli, Escrig, & Lang, 2008) and hormone secretion. Therefore, this dissertation presupposes that emotion is an amalgamation of general physiological arousal and situation cues that influence the cognitive label assigned to the experience of arousal (Schachter, 1964). This definition of emotion presumes that arousal itself is emotionally neutral. Emotion is therefore the cognitive label that a person attaches to the arousal once the person analyzes their feelings and the situational cues prompting the arousal. However, emotions can be broadly divided into two categories of positive and negative emotions. The following section will differentiate positive and negative emotions.

What Differentiates Positive and Negative Emotions

Positive and negative emotions differ from one another in several manners. This discussion will cover these various distinctions. First, I will explain the psychological and visceral difference of positive and negative emotions. A discussion of the differentiation among emotions will follow. Then, I will explain the role of the autonomic nervous system in emotions and the health effects of emotions. Finally, I will discuss the various models used to understand positive and negative emotions.

Psychological and visceral differences. At their most basic level, positive and negative emotions differ in their psychological and visceral experiences. A visceral experience refers to the way people feel emotions deep in their gut, or more generally at their core of their physical body. Compared to negative emotions, positive emotions feel better to humans (Fredrickson, 2009) because they make humans feel light and cheerful. Viscerally, positive emotions are more enjoyable than negative ones. In fact, emotions can vary according to a construct called hedonic tone (Johnston, 1999). Hedonic tone offers an evaluative component of an emotion that references its pleasantness or unpleasantness. For example, whereas happiness is considered to be a pleasant experience because of its associated sensations, sadness can easily be classified as an unpleasant human experience. That is, for most normally functioning human beings, emotions would almost certainly be catalogued in similar manners of hedonic tone. As a result of the pleasantness of the emotion, positive emotions would be considered rewarding to humans and negative emotions would be considered aversive.

Amount of differentiation. In addition to the visceral distinctions between emotions, emotions can be distinguished based on the amount of differentiation within each category of emotions. Compared to negative emotions, there is evidence of a lack of differentiation among positive emotions (Fredrickson, 1998). Negative emotions (e.g., fear, anger) each associate with specific facial combinations (i.e., expressions) that indicate unique and particular values recognized cross-culturally (Ekman et al., 1987). In other words, there are universal facial displays that convey discrete negative messages.

With the exception of a true or Duchenne smile, positive emotions lack the same unique and particular differentiations (Ekman, 1992). This genuine smile is denoted by facial muscle actions whereby the zygomaticus major lifts the corners of the mouth and the appearance of crow's feet (contraction by the orbicularis oculi) develop around one's eyes (Floyd, Mikkelson, & Hesse, 2008). Research also suggests that numerous positive emotions are communicated through this single Duchenne smile (Ekman, 1992). What further weakens the differentiation of positive emotions communicated through the face is that genuine smiles are almost indistinguishable from insincere or non-Duchenne smiles, even though they use different muscles. Observers who do not know what they are looking for may think a person is smiling because the person is genuinely happy, when in fact the individual is masking a negative emotion or simulating an emotion when none is experienced. Cumulatively, the research on positive and negative facial displays supports differentiation between the two emotion types; however, within positive emotions, there is a lack of delineation.

Autonomic nervous system activity. The autonomic nervous system (ANS) can also illustrate a disparity between positive and negative emotions. The ANS helps the human body maintain regulatory functions by controlling one's internal organs (Thayer, Hansen, & Johnsen, 2008). Specifically, it keeps one's heart beating, keeps one's blood flowing through the body, and increases the chances that the body is operating efficiently. Several studies have found significant autonomic activity resulting from the experience of negative emotions (Cacioppo, Klein, Berntson, & Hatfield, 1993; Kop et al., 2011; Levenson, 1992; Levenson, Ekman, & Friesen, 1990). On the other hand, unless a person has observed something humorous enough to cause physically taxing laughter, positive emotions are typified by a minimal amount of autonomic activation.

However, this physiological reactivity is not without purpose (Fredrickson, 1998). Nesse (1990) argues that evolution has resulted in an emphasis on negative emotions, which causes the asymmetries between negative and positive emotion. The situations that contain threats or opportunities are most shaped by natural selection. Humans face more negative emotions because they face more diverse threats than opportunities. These threats have evolved to evoke negative emotions to protect humans. Therefore, if a human fails to respond to threats to well-being, the cost to one's life is more severe than if a human fails to respond appropriately to possible opportunities (Pratto & John, 1991; Rozin & Fallon, 1987).

Different health effects. Another mechanism for differentiating positive and negative emotions is to consider the implications of negative emotions for human health. Negative emotions and implications for human health are connected through the experience of stress. First, stress must be properly defined as it is often used in such diverse ways. Cautiously, there is no universally agreed upon definition of the term stress when used in referencing biological and social systems (Hinkle, 1987). However, Selye (1950) is one of the first researchers to talk about stress. Seyle defines stress as a generic response of the body to any demand (1976). Further, he argued that when humans encounter a stressor (e.g., the demand, a threat to one's goal), they proceed through a three-stage process called the general adaptation syndrome, which refers to a linear development of the body's response to stressors. To be clear, this definition implies that all stressors are demands; however, not all demands are stressors.

This three-stage process consists of the alarm stage, resistance stage, and the exhaustion stage (Seyle, 1950). The alarm stage occurs in the absence of much information and manifests when humans are initially aware of a stressor. For example, if someone hears a loud noise or smells smoke, the body perceives that a threat exists. This is the stage that cognitively activates the fight-or-flight response. Next, humans experience the resistance stage, when they attempt to cope with the identified threat. If the alarm stage begins the process of fighting or fleeing from a stressor, the resistance stage is where one's body carries out the actions. In this stage of physically fighting or fleeing, the physiological arousal causes a depletion of energy and resources. Finally, if someone goes through the second stage long enough, he or she will enter the final stage of exhaustion. This happens when individuals expend all of their resources (e.g., physical, mental, emotional). Very often, individuals do not get to this stage. For example, students who experience stress over giving a public speech will eventually stop experiencing stress once they deliver it and it is over. Moreover, this last stage likely happens during prolonged or recurring stressors.

Stress is consequential because of its adverse effects on physical health. Hadany, Beker, Eshel, and Feldman (2006) argued that the body's reaction to stress induced, prolonged physiological arousal, has many damaging effects. These effects include cardiovascular disease, asthma, rheumatoid arthritis (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002), and increased susceptibility to infectious illnesses (Cohen, Tyrrell, & Smith, 1991; Segerstrom & Miller, 2004). Further, Herbert and Cohen (1993) proposed a model of stress that states stressors (negatively valenced life events) lead to distress (negative affective states) that then alter human immune function. Psychological stress, like its physical stress counterpart triggers several physiological systems. For instance, some information from our interpersonal and social environments activates the following physiological systems: nervous system, cardiovascular, and neuroendocrine.

When individuals are subjected to repeated activation of the human stress response or when a person experiences elongated recovery from stress, they have an increased risk for numerous negative health outcomes (Sapolsky, 2004) such as vulnerability to chronic illness and disease (Denson, Spanovic, & Miller, 2009). Therefore, any intervention that is capable of speeding up one's cardiovascular recovery from stress would be beneficial to humans. Positive emotions do not lead to the same health effects as negative emotions.

Differential emotion models. Finally, negative and positive emotions are also segregated through the models used to explain each. Specifically, although much of the research on positive emotions uses models built on negative prototypes (Fredrickson & Levenson, 1998), there are several arguments for using different models completely. Past emotion theorists have focused their attention on an explanation of general emotions; this has resulted in the construction of emotion models, which fit the most *prototypic* emotional experience (Fredrickson, 1998). Subsequently, the prototypic emotional experience seemed to coincide predominantly with emotions such as anxiety and fear. Scholars therefore assumed that the way they focused on anxiety and fear would be appropriate for all emotions because explanation of positive emotions must be subsumed by explanation of the prototypic one. However, this is not the case.

The argument for using different models of emotions stems from the fact that positive and negative emotions are fundamentally different. For instance, several models state that emotions motivate people to very specific actions or urges that are referred to as specific action tendencies (Frijda, 1986; Frijda, Kuipers, & Schure, 1989; Levenson, 1994). For example, the following emotions evoke specific behaviors: anger and attack, jealousy and surveillance, sadness and withdrawal, fear and flight or fight, surprise and self-protection, and disgust and repulsion (e.g., nausea, distancing oneself, spitting, regurgitating; Olatunji & Sawchuk, 2005). Humans may not necessarily follow the tendency with action, but the action tendency increases the probability of a particular behavior. The direction a person wants to take is influenced by the emotion experienced. Specific action tendencies are acted upon if the person is met with the appropriate amalgamation of intentions, self-efficacy, coping styles and cultural norms (Fredrickson, 1998).

Further, there are specific physiological components that prepare the body to perform the specific action. For instance, Levenson (1992) argues that when a human experiences fear and needs to either fight or flee from the scene, the body's autonomic nervous system increases blood flow to large muscles in our bodies to increase the chances that the fighting or fleeing ends in success. Put another way, specific action tendencies are a combination of automatic, but particular, cognitions and a summoning of physiological systems helpful in carrying out the behavior. This explanation of emotion works best for negative emotions, but positive emotions do not easily fit into this model (Ekman, 1992; Fredrickson, 1998; Fredrickson & Levenson, 1998).

From an evolutionary standpoint, emotions may have evolved because the action tendencies they provoke occur in consequential life-threatening situations (Fredrickson, 1998). Individuals who experience the tendencies that increase their chances of survival are more likely to pass on their genes to future generations than those individuals who lack the same mechanisms. On the other hand, this model did not likely evolve for positive emotions for two reasons.

First, positive emotions are less likely to surface when an individual faces a threat to one's livelihood. Second, they do not appear to create the same delineated tendencies for action that negative emotions provide. Fredrickson (1998) argues that because some positive emotions affect thoughts, which might subsequently affect behavioral change, the term *thought-action tendencies* is more accurate of the positive emotional experience. For instance, joy is associated with the urge to play and represents a quite generic, nonspecific thought-action tendency. Interest arises in contexts appraised as safe and as offering novelty, change, and a sense of possibility or mystery. The momentary thought-action tendency initiated by interest is exploration, whereas contentment brings an experience of "oneness" with the world. Contentment involves the urge to savor and integrate recent events and experiences creating a new sense of self and a new worldview. Finally, the emotion of love is made up of many positive emotions, including interest, joy and contentment and functions to help build and strengthen social bonds and attachment. These urges are much more general than those of negative emotions.

An examination of the thoughts and behaviors associated with positive emotions and negative emotions shows that there are several differences between the two types. Positive emotions do not correlate with urging and encouraging of behaviors in the same manner as negative emotions (Fredrickson, 1998). However, it is possible that not even all positive emotions or negative emotions can be treated as one category with the same characteristics. For example, to break free from a single general-purpose emotion model, Ekman (1994) argues that each emotion may require its own theory. At a minimum, Fredrickson (1998) suggests that a model for negative emotions and a separate model for positive emotions may be a more appropriate way to explain the human experience. Fredrickson's model for explaining positive emotions is referred to as broaden and build theory of positive emotions. This framework will be discussed in the next section.

Broaden and Build Theory of Positive Emotions

To understand Fredrickson's (1998; 2000) way of conceiving positive emotions, one must first break away from traditional models of explaining negative emotions. Fredrickson (1998) argues that emotion theorists can better explain positive emotions if they are willing to set aside two presuppositions. First, theorists studying emotion should set aside the notion that an emotion must lead the body to specific behavioral tendencies. Broaden and build theory (BBT, Fredrickson, 1998; 2001) hypothesizes that positive emotions broaden the scope of attention and thought-action repertoires (Fredrickson & Branigan, 2005). For instance, experiments (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008) have demonstrated that positive emotions widen the scope of visual attention, broaden repertoires of desired actions, increase openness to new experiences and critical feedback, increase the sense of oneness to close others, increase trust in acquaintances, and increase our ability to accurately recognize individuals of another race compared to our own race.

Second, theorists should do away with the presupposition that argues for emotions to lead to specific action tendencies. As a result of this expanding of a person's behavioral scripts, positive emotions might be better conceived as *nonspecific action tendencies*. Additionally, positive emotions may actually change the way people think, which may, but not necessarily require, physical activity to follow (Fredrickson, 1998). This focus on cognition over action can be named *thought-action tendencies*. For example, Frijda (1986) found that the experience of joy positively linked with a broader set of actions compared to those not experiencing joy.

Life-threatening events typically result in negative emotions more often than positive ones. When there is no such threat, very rarely does one's livelihood require fast and committed decisions or actions. As such, not every emotion necessarily sparks a specific action tendency. If negative emotions narrow one's focus to specific behaviors, it might be possible that the emotions that do not fit this model (e.g., positive emotions) proceed along an alternative process. For example, some positive emotions specifically do not narrow a person's thoughts and actions to specific ones. Fredrickson (1998; 2003) suggests that positive emotions might change a person's thoughts and behaviors by broadening the momentary thought-action tendencies of individuals.

To be clear, Fredrickson claims that positive emotions undo the effects of negative emotions by broadening thought-action repertoires or tendencies. The cognitive broadening expands the way people think and adds several categories of resources to the human who experiences positive emotions. Next, I will address the research that supports the various broadening effects of positive emotions.

Positive Emotions Broaden the Mind and Supply Resources

Positive emotions, through the cognitive broadening of thought-action tendencies, produce broader attention and mindsets and add several categories of resources for people including physical, social, intellectual, and psychological. By having an understanding of the various cognitive broadening effects of positive emotions, one might glean some insight into why Fredrickson argues that positive emotions could subsequently offset the effects of negative emotions and stress.

Broadening one's attention. One of the ways that positive emotions broaden thought-action tendencies is by widening the way people think about and perceive information from their environments. Specifically, one's peripheral vision increases when experiencing positive emotions. Fredrickson and Branigan (2005) showed participants a film clip that elicited a) amusement, b) contentment, c) neutrality, d) anger, or e) anxiety. They examined the broadening and narrowing of one's scope of attention using a global-local visual processing task. This task presents the participant with various pictures to assess how wide a person's visual attention goes. Afterward, participants were asked to examine geometric figures and report on what they saw. Whether or not participants saw three separate squares or a larger triangle was effected by their emotional experience before the task. For instance, people experiencing positive emotions see the larger triangle (the big picture). However, compared to higher amounts, people experiencing lower amounts of positive emotions tend to see three squares (the localized pictures), because their peripheral vision is reduced. Further, another study showed that when flashing sets of photos across a computer screen, those experiencing positive emotions see more of the photos than those experiencing negative emotions (Waldlinger & Isaacowitz, 2006). There does not seem to be a threshold that maxes out the benefits at a certain level of positive emotion. Even the highest of arousing positive emotions (e.g., elation) lead to a broadening of a person's attentional focus (Derryberry & Tucker, 1994).

Broadening one's mind. Broaden and build theory also argues for a cognitive broadening of one's mind. Another experiment by Fredrickson and Branigan (2005) examined the broadening and narrowing of thought-action repertoires using an open-ended Twenty Statements Test, which asks people to describe what they would like to do as a result of their positive emotional experience. Compared to a neutral state, positive emotions broadened the scope of thought-action repertoires. Broaden and build theory of positive emotions suggests that one's scope of cognition widens when experiencing positivity (Isen, Daubman, & Nowicki, 1987). Here, positive emotions have been linked to thoughts that are flexible, inclusive, creative, and integrative. Compared to individuals in a neutral control group, a positive affect group was better able to name more unusual associations to negative words (Isen, Johnson, Mertz, & Robinson, 1985) and tended to use more inclusive categories for describing words (Isen & Daubman, 1984; Isen, Niedenthal, & Cantor, 1992). Additionally, participants experiencing positive emotions tend to use more inclusive categories when organizing objects. Several experiments illustrate that participants who experience positive emotions also exhibit higher creative thinking skills. These studies rely on a creativity test, which asks participants to come up with one word that associates with three others (Isen, Daubman, & Nowicki, 1987). Isen (1987) proposes that positive affect helps people develop connections between constructs they would not ordinarily see. Taken together, these empirical studies support the argument that positive emotions broaden one's scope of cognition.

Building resources. Resources are another benefit of positive emotions. The more resources a person possesses, the more likely one can successfully manage all that life has to offer. These additional resources likely result in being more successful, happier and healthier that those lacking the same resources. Positive emotions broaden one's thought-action repertoires and provide access to numerous resources for individuals including physical, social, intellectual, and psychological resources.

Physical resources. Physical resources include physical skills and health (Boulton & Smith, 1992; Danner, Snowdon, & Friesen, 2001). Fredrickson and

Losada (2005) examined several measures of positive psychological and social functioning by asking participants to log onto a secure website for 28 consecutive days. These individuals indicated the extent to which they felt each of 20 various positive and negative emotions. The positive emotions included amusement, awe, compassion, contentment, gratitude, hope, interest, joy, love, and pride. Individuals who reported having a positive to negative emotional ratio of at least 2.9 to 1 exhibited stronger positive psychological functioning in the following areas: self-acceptance, purpose in life, environmental mastery, positive relations with others, personal growth, and autonomy and stronger social functioning in the areas of social coherence, social integration, social acceptance, social contribution, and social actualization. Those who experience positive emotions also gain a physical health advantage in that they are better able to fight off the common cold (Fredrickson et al., 2008).

In addition, positive emotions create an urge to play, which can have several positive benefits for an individual (Cohn & Fredrickson, 2006; Fredrickson, 2003). For instance, those experiencing positive emotions are better at generating unusual uses for everyday objects (Kok, Catalino, & Fredrickson, 2008). Also, when “play” objects elicit interest, children show a wider range of types of play, more variations of action, and longer play episodes. Positive emotions can lead to play, which can also help facilitate muscle growth and cardiovascular fitness. Specifically, play serves to build specific locomotor skills that can be drawn on later during emergencies. Two examinations of animal behavior illustrate this function of positive emotions. Boulton and Smith (1992) found that male pup elephant seals played in a manner that resembles the fighting seen in adult males of the species. Also, in a study of rhesus monkeys, juveniles play by imitation biting, not meant to harm. These playful activities subsequently prepare the species for circumstances they will face in the future.

Social resources. The second type of resources offered by positive emotions is social resources. Social resources refer to friendships and social support networks which are bolstered by positive emotions (Aron, Norman, Aron, McKenna, & Heyman, 2000; Lee, 1983). Waugh and Fredrickson (2006) examined the effects of positive emotions on self-other overlap during the initial formation of relationships between participants who had just arrived at their first year of college and did not know their new roommate. Initial interactions between people offer an opportunity for individuals to receive social capital that can guard against stress and promote better health. Positive emotions were associated with how close two individuals get during the first few days of a relationship. Results suggest that positive emotions broaden and expand people's sense of self to include close others.

Also, positive emotions increase the varied and adaptive ways one uses a social support network (Cohn & Fredrickson, 2006). When we share positive emotions with other people, we create lasting friendships or strengthen already existing familial bonds. These bonds allow individuals to call upon relational partners in a time of need. Examples include newborns whose smiling appears to be an innate facial response. These smiles given to parents or guardians might act as rewards that increase the likelihood the child is continuously protected

(Tomkins, 1962). Individuals are also more likely to help another person if they experience some level of positive emotions like joy. Isen and Levin (1972) gave participants' cookies, or some gift. Compared to those who did not receive gifts, those who did were more likely to help a stranger pick up a pile of dropped papers, volunteer their time to help others, or make a phone call on someone else's behalf.

Intellectual resources. The third category of resources is intellectual resources, which include knowledge, theory of mind, intellectual complexity, and executive control (Csikszentmihalyi & Rathunde, 1998; Lesley, 1987; Panksepp, 1998). Fredrickson, Cohn, Coffey, Pek, and Finkel (2008) suggest that intellectual or cognitive resources might include the ability to mindfully pay attention in the immediate moment. Individuals who were given a small candy treat were better at negotiating an agreement in a bargaining task than those who did not receive the treat (Carnevale & Isen, 1986). Positive emotions also encourage approach behaviors (Fazio, Eiser, & Shook, 2004), which can be useful in collecting information about one's environment (Kok, Catalino, & Fredrickson, 2008). Individuals are also better at recognizing faces when experiencing positivity (Johnson & Fredrickson, 2005). That is, humans can take in more of a person's face when they are infused with positive emotional experiences. In addition, positive emotions increase a person's use of adaptive reframing and perspective taking which are examples of coping skills (Fredrickson & Joiner, 2002). Finally, psychological resources include resilience, optimism, and creativity (Folkman & Moskowitz, 2000; Fredrickson, Tugade, Waugh, & Larkin, 2003). These might also include a feeling of self-efficacy in dealing with environmental strains (Fredrickson et al., 2008).

Psychological resources. Positive emotions associate with more creative and flexible ways of thinking (Kok, Catalino, & Fredrickson, 2008). Isen (1987) used a task where participants who were given several items were asked to solve a problem using the objects. The participants who felt positive emotions before the task came up with more creative solutions than those who felt negative or no emotions. These four types of resources acquired through states of positive emotions are long lasting. Even when the emotional experience has subsided (left the person), these resources still exist to be used at some point in the future.

Given the research on the broadening effects of positive emotions, Fredrickson asserts that positive emotions will also result in offering specific health benefits or resources to the human experiencing them. Further, by broadening a person's thought-action tendencies, positive emotions actually unwind the harmful heightened cardiovascular reactivity forced by negative emotions. This argument takes shape in the undoing hypothesis of positive emotions, which will now be addressed.

The Undoing Hypothesis of Positive Emotions

Within the parameters of BBT, the undoing hypothesis (Fredrickson, 1998, Fredrickson & Levenson, 1998) argues that positive emotions themselves do not call forth specific action tendencies or urges; therefore, they do not subsequently require an increase in cardiovascular activity to carry out the urge. On the other hand, positive emotions may exist to suppress the cardiovascular response that is initiated by negative emotions (Fredrickson et al., 2000). Testing this hypothesis requires an initial state of arousal caused by the experience of negative emotions (Levenson, 1988). If negative emotions focus one's physiology (e.g., cardiovascular reactivity) for specific urges, positive emotions might undo this preparation by quickening the return of one's body to a less aroused state. Subsequently, this less aroused state would open up the variety of behavioral tendencies the individual might be inclined to pursue. Fredrickson et al. (2000) therefore argues that "positive emotions have a unique ability to down-regulate lingering negative emotions and the psychological and physiological preparation for specific action that they generate" (p. 240).

The undoing hypothesis of positive emotions (Fredrickson, 1998; 2000) is therefore predicated upon the notion that negative and positive emotions might complement each other. This relationship coincides with an ability to use positive emotions to help regulate the effects of negative emotions. Given the broadening of individuals' thought-action repertoires, positive emotions should provide a counterweight to the effects of negative emotions. This counterweight, or antidote, means that positive emotions will broaden thought-action tendencies which will likely reverse the deleterious effects of negative emotions (Fredrickson & Levenson, 1998; Levenson, 1988). Khosla (2006) also discovered that positive affect returns a person's physiology to homeostatic balance by undoing the persisting after-effects experienced from negative emotions.

In Fredrickson and Levenson's (1998) test of the undoing hypothesis, they set out to support the claim that positive emotions speed one's cardiovascular recovery from the effects of negative emotions. A fear-eliciting film clip was first shown to participants. This followed with several clips designed to cause contentment, amusement, sadness, and neutrality. Compared to those participants in the neutral or sad secondary film conditions, those in the positive film condition exhibited quicker returns to their pre-film cardiovascular activity. Cardiovascular activation was assessed through inter-beat interval, pulse transmission to the right ear, pulse transmission time to one's second finger, and finger pulse amplitude. All four measures were averaged together to produce a single assessment of cardiovascular activation. Results indicated that the two positive film clips elicited significantly faster returns to baseline levels of arousal than the neutral film clip with medium to large-sized effects (contentment film clip, $r = .40$; amusement film clip, $r = .40$).

A follow-up test of the undoing hypothesis (Fredrickson et al., 2000) set out to build upon the findings of the study described above. Instead of using a negative emotion-eliciting fear clip, researchers used a public speaking stressor designed to elicit fear and anxiety. Like the previous study, four emotion-eliciting film clips were used: contentment, amusement, sadness and neutrality. Six measures assessed the amount of cardiovascular activity for participants and included: heart rate, finger pulse amplitude, pulse transmission times to the finger, pulse transmission time to the ear, diastolic blood pressure and systolic blood pressure. In this study, results indicated small to medium effects such that those who viewed the contentment film clip ($r = .18$) and those who viewed the amusement film clip (r = .17) showed faster cardiovascular recovery or return to baseline arousal than those who viewed the neutral clip.

One argument against the postulates of the undoing hypothesis is that the arousal from positive emotions might simply be replacing arousal from negative emotions, but not actually undoing it (Fredrickson & Levenson, 1998). If positive emotions have their own cardiovascular signature, then what might be occurring in these tests is simply changing out the cardiovascular reactivity of negative emotions with that of positives ones. This replacement argument subsequently requires that the contentment and amusement positive film clips cause a lower amount of sympathetic nervous system activity than the neutral film clip. Fredrickson et al. (2000) claim that to falsify this possibility, they would have to find that there is no difference in cardiovascular reactivity between the neutral and two positive film clips. In fact, results showed that the cardiovascular activity of the positive and neutral film clips were not different. This replacement effect was not supported; however, additional consideration does offer some alternative places where the undoing hypothesis might need to be refined.

What Do Positive Emotions Actually Undo?

Although the original conceptualization of the undoing hypothesis examines positive emotions against a backdrop of negative emotions, it is possible that the parameters of this hypothesis can be alternatively explained. For instance, although Frederickson (1998) and Fredrickson et al. (2000) found that positive emotions undid the physiological effects of negative emotions, this may not be the entire scope of the undoing hypothesis. That is, the question arises, what do positive emotions actually undo? Earlier, I defined arousal as physiological changes in the sympathetic nervous system including heart rate, blood pressure, and respiratory rate. On the one hand, the undoing effect of positive emotions may be limited to offsetting the arousal of negative emotions only. On the other hand, positive emotions may possess the ability to offset more emotion-neutral arousal generally. Each of these possibilities will be discussed subsequently.

If Undoing is Limited to Negative Emotions. First, if the undoing effect is limited to negative emotions, then positive emotions will continue to represent a possible antidote to the deleterious arousal of negative emotion. This would imply there is something unique about the negative emotion arousal (compared to no emotion arousal) that allows it to be undone with a positive emotional experience. The undoing mechanism of positive emotions is helpful, even if only applied to the effects of negative emotions.

Positive emotions are beneficial because they have already been shown to undo the arousal resulting from negative emotions (Fredrickson, 1998; Fredrickson, 2001). This study is going to compare arousal resulting from an induced negative emotion and arousal induced through a simple emotion-free exercise task. If this dissertation finds that the undoing effect of positive emotions are limited to negative emotions specifically, this will provide further substantiation for the undoing hypothesis. Finally, this will also provide further evidence that there is a unique quality about positive emotions. This quality may suggest that positive emotions have evolved to be a mechanism for humans to offset the harmful arousal from negative emotions only.

If Undoing Expands to Arousal Generally. On the other hand, if the undoing hypothesis is applicable to arousal generally, several considerations also have to be pondered. First, even an emotionally neutral stimulus can bring about prolonged cardiovascular reactivity, and might be just as harmful as the effects of negative stimuli. For instance, some exercise research (Bouchard, 2012) suggests that specific individuals do not have a healthy recovery from heightened cardiovascular activation (Maddox, Ross, Ho, Magid, & Rumsfeld, 2009; Morise, 2004). Arousal and physiological stress are not absolutely associated with negative emotions. Because the human body may shut down particular immune functions and other physiological systems when experiencing long-term arousal (Kemeny, 2003), a mechanism for undoing even this emotionally absent arousal might still provide positive health effects.

In addition, although arousal may appear to be present only during emotional experiences, research has indicated that one's body can be in an aroused state when no emotional experience is occurring. For instance, neutral arousal has been examined in several studies of arousal theory. For instance, Murstein (1986) describes several studies where men are aroused by a neutral stimulus in order to test numerous variables related to attractiveness. In one of the studies, male participants jogged in place for two minutes and then they were shown pictures of women who they rated on levels of attractiveness. In another study, White and Kight (1984) successfully used exercise, specifically jumping rope as the neutral arousal stimulus. These studies make a case that one's cardiovascular system can in fact be elevated even when no emotion is experienced. If an individual endures prolonged cardiovascular reactivity as a result of an emotionally neutral stimulus, it is possible that the same harmful effects as negative emotions (e.g., cardiovascular disease, asthma, and increased susceptibility to infectious illnesses) might follow.

This dissertation research will use minor physiological arousal (e.g., a step-stool task) to simulate the cardiovascular effects of the stress manipulations used in previous tests of the undoing hypothesis by Fredrickson and colleagues. If positive emotions undo the physiological effects of small amounts of experimentally manipulated arousal (a neutral emotion condition) at a similar rate as undoing the physiological effects of stress from negative emotions, the original undoing hypothesis will need to be refined to account for these outcomes. In addition, this might also suggest that positive emotions evolved to offset any harmful physiological arousal, not just that from negative emotions.

Research Questions

As a result of the discussion regarding positive and negative emotions, arousal and the undoing hypothesis, the following research questions are posed:

RQ_1: Do positive emotions undo the cardiovascular reactivity of an emotionally neutral stimulus?

RQ_2: Is there a difference between the undoing of cardiovascular activity by positive emotions when participants experience an increase in physiological arousal due to exercise versus public speaking stressor?

Chapter 2

METHODOLOGY

This dissertation requires several components to come together to accurately replicate Fredrickson's original studies. This chapter will first begin with a description of the pilot study that was conducted to determine the nature of the full dissertation's components. Specifically, I will address the selection of video clips as well as the level of exercise chosen for this study. Then, the participants and inclusion and exclusion criteria will be offered. Subsequently, procedures, manipulation checks and data analysis strategy for the full dissertation study will be discussed.

Pilot Study

Two soundless video clips lasting 100-seconds will serve as one of this project's two experimental manipulations. The clips from Fredrickson et al.'s (2000) study were not used due to their relevancy to the target population. That is, Fredrickson suggests that the older the emotion-eliciting film clips get, the less emotionally evocative they are because of changing expectations of the target population (B. Fredrickson, personal communication, August 29, 2011). To determine which specific film clips would be used in the main dissertation study, a pilot test was conducted in two classrooms.

The two types of film clips to be used in this study include a neutral film clip (no emotion elicited) and a happy film clip (positive emotion elicited). They were selected using the following assessment. Three examples of each type (i.e., three neutral clips and three positive clips) were pilot tested. Students were divided into three groups of 10 students for each film clip. One group at a time was brought into a classroom and asked to take a seat. Once seated, the experimenter gave out an emotion report form and participants were asked to indicate their current level of emotion at that time. Afterwards, the forms were collected and participants were shown a 100-second video clip. For the three neutral (no emotion elicited) film clips, groups were shown either a) a man in front of a black background talking to another person just off camera, b) an abstract video of sticks smoking and catching on fire, or c) a nature video which showed considerably dull footage taken in a dry field. The same procedure was followed to test the three happy (positive emotion elicited) film clips. These groups were shown either a) a dancing scene from the film, “Singing in the Rain,” b) waves crashing on a serene beach, or c) a little puppy playing with a big ball.

After observing the no emotion or positive emotion film clip, participants were then given another emotion report form and they were asked to report how they felt after watching the video clips. *T* tests were used to determine the emotional changes caused (or not caused) by the film clips. First, the no emotion film clip selected involved the man silently speaking to another just off camera. This clip was chosen because it provided almost no changes in affect. Second, the happy video clip selected involved the tiny puppy playing with a large ball. Of the three positive film clips, this clip provided the largest effect ($r^2 = .21$) for happiness. In addition, of the other emotions tested, all other affects fit the desired pattern for this dissertation.

In addition to the film clips used in this study, an exercise arousal task also had to be pilot tested. Specifically, a pilot test was conducted to determine the cardiovascular rigor of and effects from stepping up and down on a step stool. To consistently enable pilot test participants to know when they should step up and down, a metronome application was used on an electronic device. Various settings were tested; however, a metronome count of 70 was found to provide a level of physiological arousal roughly equivalent to the speech preparation stressor used in the original study on the undoing hypothesis (Fredrickson et al., 2000). The amount of physiological arousal from Fredrickson's study was calculated by finding the percent increase of arousal from baseline to the anxiety induction (speech preparation task). The metronome count was also adjusted to account for the amount of time that participants would have to walk up and down.

Participants for Full Study

To determine the sample size that should be included in this dissertation, Fredrickson's two previous studies on the undoing hypothesis were analyzed. Neither study provided all of the information that would be useful in determining the relevant sample sizes for the replication design of this dissertation. However, whatever information could be gleaned from those empirical tests has been utilized below. First, when examining the differences in cardiovascular reactivity for the two film conditions, Fredrickson (1998) used a composite measure of cardiovascular reactivity and found that participants who viewed a positive film clip exhibited a faster return to cardiovascular homeostasis compared to a neutral film clip. This research found an effect size of $r = .40$, $\eta^2 = .16$. To find an effect size of similar magnitude, with a power of .95, an a priori power analysis indicates that at least 72 participants should be included in the study.

Further, Fredrickson et al. (2000) used separate measures of cardiovascular reactivity to determine if the stress induction increased arousal as predicted. In addition, they found that the stress induction (a speech preparation task) successfully affected three measures of cardiovascular reactivity including heart rate, systolic blood pressure and diastolic blood pressure. The effect sizes were as follows: heart rate increase (r = .41, η^2 = .17), systolic blood pressure (r = .34, η^2 = .12), and diastolic blood pressure (r = .16, η^2 = .03). For this dissertation, 88 individuals will be included in the study to increase the chances of finding similar effects at the following power levels: heart rate (power = .95), systolic blood pressure (power = .81), and diastolic blood pressure (power = .24). Regarding diastolic blood pressure, although the study is underpowered for that measure, the following rationale is offered. First, the effect size is so small for diastolic blood pressure that to achieve even a minimal power of .80, 360 individuals would need to be included in the sample. Some clinical research suggests that systolic blood pressure is more informative on health matters than diastolic blood pressure (Pastor-Barriuso, Banegas, Damian et al., 2003). Further, Izzo, Levy, and Black (2012) recommend in a clinical advisory statement from the National Heart Lung and Blood Institute that there is a substantial shift in using systolic blood pressure as the foremost benchmark for diagnosis, staging, and therapeutic management of cardiovascular related issues. Furthermore, because systolic blood pressure is a better predictor of cardiac and vascular disease, it is privileged over diastolic blood pressure. As a result, more attention is directed in this dissertation to finding a difference in systolic blood pressure. In addition, with such a small effect size, it is not worth replicating, as it would be a waste of resources.

Subsequently, as advised by the power analysis described above, participants ($N = 88$) were 36 men and 52 women ranging in age from 18 to 30 ($M = 20.10$, $SD = 2.07$). Participants self-identified as the following ethnicities: Caucasian (67%), Hispanic (15%), Asian (6%), Black (5%), Refused to Answer 6%, Other (4%), and American Indian (1%). These percentages exceed 100 because participants were allowed to self-identify with more than one group.

The human subjects protocol was approved (see Appendix A). In addition, participants were recruited from undergraduate courses in the communication department at a large university in the southwestern United States. The study was advertised through e-mails sent to instructors, which asked for their permission to allow their students to take part in this study. In compliance with the instructor's policies, I offered extra credit for participants' involvement. To instructors, I included the study's details in electronic form (see Appendix B), which included a link to the online questionnaire (conducted through www.questionpro.com and used for initial screening procedures, as described below).

Inclusion and Exclusion Criteria

Prospective participants completed multiple prescreening measures in order to establish eligibility for this study. Through an online survey on www.questionpro.com, participants responded to several questions used for screening purposes. To be considered eligible, potential participants had to report normal blood pressure, be non-smokers, never have received chemotherapy or chest radiation, no history of hepatitis, no endocrine disease, no rheumatologic disorders, no respiratory problems or diabetes, never had a heart attack, no cardiac arrhythmias, no heart disease and no reported use of steroids. These exclusions helped promote a baseline cardiovascular level that falls within normal limits for healthy adults. Further, female participants were not currently pregnant at the time of the study, because as Goldkind, Sahin, and Gallauresi (2010) argue, pregnant women should only be included in research when there is a theoretical reason to do so. Additional exclusion criteria stipulated that potential participants should not have ever been diagnosed with personality disorders, anxiety disorders, mood disorders or clinical depression. These additional exclusions helped reduce the number of additional effects on one's positive or negative emotional report.

Procedures

Participants were tested individually by one of two experimenters. The experimenters were either the author of this manuscript or an undergraduate research assistant trained in appropriate laboratory procedures. Upon arriving to the communication lab, researchers seated participants in a chair at a table in a well-lit room. Researcher informed participants of the study's purpose and told that the study is about emotional reactions, that they would be videotaped and that physiological indicators would monitor their body's reactions. After participants were asked to sign a consent form (see Appendix C), the experimenter attached equipment for physiological measurement. Experimenters randomly assigned participants to conditions before the start of the data collection period. Random assignment was blocked by participant sex.

The experimental procedures began with a five-minute period of adaptation. Participants then filled out the first of three emotion reports. Participants were then shown a digital video recording, which told them to "relax, and empty your mind of all thoughts, feelings and memories." This subsequently began a resting baseline period lasting two minutes, the second of which was used as the pre-task baseline measure. After a baseline measurement had been taken, participants were given one of two sets of instructions. For those in the exercise group, they were read the following instructions:

> You are going to be asked to step up and down on a step stool for 60 seconds. You will follow this pattern. (Researcher DEMONSTRATES stepping up, 1, 2, stepping down, 3, 4, stepping up 1, 2, stepping down 3, 4.) I will tell you when to begin stepping. I will tell you when to sit down. I will not be watching you step up and down, so your goal is to mirror what I have just shown you as best you can. Afterwards, you will be shown a video clip and a coin toss computer program will determine what you see.

For those in the public speaking task group, they were read the following instructions:

> You are going to have 60 seconds to prepare a 3-minute speech on "Why your college tuition fees should be increased." You can not argue anything else. After 1 minute, an automated coin toss computer program will flip a coin on screen to determine if you are selected. If the coin flip lands on heads, you will be shown on-screen instructions that will tell you when to begin delivering your speech to that video camera up there (point to camera on wall) and your speech will be taped and graded by your peers in another study. If the coin flip lands on tails, you will be shown a short video clip. You may not begin planning.

In actuality, no participants delivered a speech, and all viewed a film clip (i.e., either the positive emotion or no emotion film clip). This cover story was used both to boost the anxiety induced by the speech task and to justify the switch to an unrelated film clip. Participants completed another emotion report for how they felt immediately after their arousal induction, which served as a manipulation check.

After their particular engagement in either the speech preparation or exercise task, participants were randomly assigned to one of two video clips. After exposure to the video clip, a three-minute post film period with a blank video monitor followed. At the conclusion of the post-film period, participants then completed another emotion report for how they felt after viewing the randomly assigned video clip.

Measures

Cardiovascular measures. To assess physiological arousal from the experimental conditions and video clips, S*ystolic blood pressure* (SBP)*, diastolic blood pressure* (DBP), *heart rate,* and mean arterial pressure (MAP) was measured via the ausculatory method using a Critikon Dinamap Pro 100 sphygmomanometer (GE Medical Systems, Milwaukee, WI). The Dinamap sphygmomanometer complies with the American National Standards Institute - Association for the Advancement of Medical Instrumentation (AAMI, 1987; 1993) SP-10 standards for NIBP accuracy. An arm cuff was placed around the participants' left arms. This cuff automatically inflated and deflated as each reading was taken. Readings were taken every minute beginning with the pre-task baseline assessment and ending 2 minutes after the viewing of the second video clip. Participants' heart rates, systolic blood pressure, diastolic blood pressure and mean arterial pressure will serve as the dependent variables.

Subjective experience of emotion. To measure the emotions experienced by participants', Ekman, Friesen, and Ancoli's (1980) subjective experience of emotions assessment was used (see Appendix D). This assessment has shown to be effective in explaining the differential reactions people have to stimulus films (Ekman & Friesen, 1974). This unipolar scale contains a list of 9 emotions. Participants are asked to indicate the strength of the emotion they feel with a 0 representing no emotion and 8 representing the strongest feeling. Instructions specifically said, "strength of a feeling should be viewed as a combination of (a) the number of times you felt the emotion—its frequency; (b) the length of time you felt the emotion—its duration; and (c) how intense or extreme the emotions was its intensity." Of the nine emotions, two are given specific explanations with participants being told the emotion *pain* refers to the experience of empathetic pain and the emotion *arousal* referring to an index of one's total emotional state.

Data Analysis Strategy

Manipulation checks. The arousal induction was created, using a public speaking stressor, to increase cardiovascular reactivity so that it could be compared to the cardiovascular reactivity of the exercise induction. To test the efficacy of these two inductions, I compare each of the four conditions' baseline (T_1) cardiovascular reactivity to the cardiovascular reactivity measured after each induction (T_3). The baseline values will be compared to induction values using a 2

X 2 mixed-model analysis of variance (ANOVA) with time as the within-subjects factor and induction (public speaking and exercise) as the between-subjects factors. Significant main effects for time, higher inductions values over baseline values, and the absence of other significant main or interaction effects will indicate success for the cardiovascular reactivity inductions.

In addition, the two inductions were also selected for their abilities to invoke specific emotions. The exercise task was selected for its emotionally neutral nature and the public speaking stressor was selected for its negative emotion invocation. To test the efficacy of the exercise induction to promote the desired no emotion state, repeated measures analysis of variance tests of the subjective emotional reports will ensure that the participants' emotional states were unchanged after exposure to the exercise task. Second, for the public speaking stressor, repeated measures analysis of variance tests of the subjective emotional report will test to make sure that the negative emotion of fear significantly increased after exposure to this stressor.

Manipulation checks are also necessary to assess the film clips used in this dissertation. Specifically, the neutral and positive film clips were chosen for their abilities to invoke the desired emotional effects (none and positive, respectively). The "man talking" film clip was selected for its no emotion invocation and the "tiny puppy, large ball" film clip was selected for its positive emotion invocation. To test the efficacy of the "man talking" film clip to promote the desired no emotion state, repeated measures analysis of variance tests of the subjective emotional reports will ensure that the participants' emotional states were unchanged after exposure to this film clip. Second, for the “tiny puppy, large ball” film clip, repeated measures analysis of variance tests of the subjective emotional report will test to make sure that the positive emotion of happiness significantly increased after exposure to this film clip.

Quantifying cardiovascular reactivity. Fredrickson (1998) and Fredrickson et al. (2000) calculated the duration of cardiovascular reactivity to the stressors using equipment that allowed for a beat-by-beat measurement of cardiovascular activation. However, this equipment was unavailable to me. Therefore, I used equipment that allowed for cardiovascular reactivity assessment at intervals no less than every minute. Therefore, I took the raw data from each of the four cardiovascular measures: systolic blood pressure, diastolic blood pressure, heart rate, and mean arterial pressure. These serve as the dependent variables. Each minute, all four of these measures were taken for a total of 8 times. The second measurement was used as the baseline, therefore, the first measurement was unused and the second measurement became Time 1 (see Table 1). In addition, because several subjects’ Time 7 (T_7) scores were not recorded due to experimenter error, cardiovascular scores at this time were excluded. As a result, there are only 6 intervals of cardiovascular measurement.

Factor analysis of emotions. Nine emotions were assessed both before and after the arousal inductions. To reduce the number of comparisons in these emotion manipulation checks, a factor analysis was conducted to determine if responses could be collapsed into positive and negative emotions. Specifically, for this factor analysis, nine items were entered into a principal axis exploratory factor analysis with Oblimin rotation and a maximum of 25 iterations for convergence. The Kaiser-Meyer-Olkin measure of sampling adequacy, with a coefficient of .70, was above the minimally accepted level of .50, suggesting that a factor analysis is appropriate with these nine variables. The second measure of psychometric adequacy, Bartlett's test for sphericity, was significant (χ^2 (36) = 191.88, $p < .001$) and indicated that the emotions items were sufficiently correlated to perform meaningful factor analysis.

In addition, eigenvalues greater than one were initially examined, followed by the representation of factors in scree plots. An examination of eigenvalues produced three factors, accounting for 63.86% of the common variance. In addition, the scree plot illustrated leveling between the third and fourth factors. However, these two mechanisms for determining the number of factors have been criticized as being misleading and inadequate for various reasons (Crawford, et al., 2010; Tabachnick & Fidell, 2007). As a result, parallel analysis (Crawford et al., 2010; Hayton, Allen, & Scarpello, 2004) was used to determine the number of factors. The parallel analysis denoted that a 2-factor solution best represented the data when eigenvalues from the target data set were compared to eigenvalues from 100 random permutations of the raw data set: (a) Factor 1: 2.22 vs. .66; (b) Factor 2: 1.34 vs. .45.These two factors represent 52.73% of the common variance. The third factor from the scree plot and eigenvalue examinations was excluded as a result of the parallel analysis, which indicated that the observed eigenvalue for factor three was less than the randomly permutated one.

The factor loadings were treated such that an item was considered loaded on a factor if the primary loading was greater than .50 and the secondary loadings were less than .32 (Costello & Osborne, 2009; McCroskey & Young, 1979; Tabachnick & Fidell, 2001). Factor loadings for all items in the final two-factor solution are presented in Table 2. The first factor is labeled *negative emotions* includes pained, anger, fear, and sadness. The second factor is labeled *positive emotions* consisting of happiness and interest. These factors will be used in the manipulation checks that will be discussed in the next chapter.

Addressing the research questions. Finally, I use a 2 X 2 mixed model ANOVA to address the two research questions. The factors are arousal condition and film clip. The levels for the first factor of arousal condition are the exercise task and public speaking stressor, the levels for the second factor of film clip are neutral emotion and positive emotion film clips. The experimenter was entered as a fixed factor in an ANOVA to assess the possibility of an experimenter effect; however, there was no effect present. The dependent variables are all four measures of cardiovascular activity assessed at each one-minute interval.

Chapter 3

RESULTS

The following section provides statistical results that address the two research questions. First, however, I provide manipulation checks information in three parts. Part one describes participants' emotional changes resulting from the two arousal inductions. Part two describes emotional changes resulting from the two film clips. Part three describes the extent to which the arousal inductions actually increased cardiovascular arousal. After the manipulation checks are discussed, I will subsequently address results germane to the two research questions.

Manipulation Checks

Several manipulation checks must be assessed before addressing the research questions. These checks can be divided into two categories: emotional changes and cardiovascular changes. First, using subjective reports of emotions, I will address whether the arousal inductions and the film clips induced the desired emotional changes. Second, I will discuss whether the arousal inductions increased cardiovascular activity.

Emotional changes from arousal inductions. To determine if the two arousal inductions evoked the appropriate emotions (i.e., no change in relevant emotions for the exercise task and an increase in negative emotions for the public speaking stressor), a manipulation check was conducted. The exercise and public speaking tasks were designed to evoke specific emotional responses. For instance, the exercise task was chosen because previous research (White & Kight, 1984) suggested that it could be used to increase physiological arousal without prompting emotions. The public speaking task was utilized for its previous success in evoking both physiological emotions and negative emotions (Feldman, Cohen, Hamrick, & Lepore, 2004). To check the emotion effects of the two arousal inductions, I ran two two-way repeated measures analysis of variance (ANOVA) tests with stressor as a between subjects factor and time as a within subjects factor and the two emotional factors that emerged from the factor analysis (i.e., negative and positive) as dependent variables. Specifically, the individual variables representing each factor were averaged to provide a single score for each factor. The independent variable, stressor, included two levels, exercise task and public speaking task. The second independent variable, time, included two levels, the subjective emotional assessment before the stress task (T_1) and the subjective emotional assessment after the stress task (T_3; see Table 1).

Ideally, the exercise arousal induction should exhibit no change in either negative emotion or positive emotions. Further, the public speaking arousal induction should exhibit an increase in negative emotion and a decrease in positive emotion. Independent-samples *t* tests indicate (see Table 3) that before exposure to the arousal inductions, there was no difference in negative emotion ($d = .02$), or positive emotion ($d = .08$), between the exercise and public speaking groups.

Negative emotions. For the negative emotions factor, the repeated measures ANOVA revealed a significant multivariate time main effect, Wilks' Λ

= 0.94, F (1, 86) = 5.44, $p < .05$, partial $\eta^2 = .06$. The main effect indicates that negative emotion increased over time from before participants were exposed to the arousal inductions to after.

This main effect is qualified by significant multivariate time by stressor interaction, Wilks' Λ = 0.82, F (1, 86) = 18.46, $p < .01$, partial $\eta^2 = .18$. This interaction is disordinal, thereby rendering the main effect of time uninterpretable. To probe the significant interaction effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was made, resulting in a corrected critical alpha of .025. First, a paired samples t test showed that for the exercise task, there was a significant decrease in negative emotion from before exposure to the stressor (T_1) to after (T_3), t (43) = 2.33, $p < .025$, d = .24. A second paired samples t test showed that for the public speaking task, there was a significant increase in negative emotion from before exposure to the stressor (T_1) to after (T_3), t (43) = -3.66, $p < .001$, d = .60. The means for these tests can be found in Table 3.

The interaction effect indicates a decrease in negative emotion for the exercise group and an increase in negative emotion for the public speaking group. The exercise task was chosen as an arousal induction that would not result in an increase in negative emotion so that it could be compared to the public speaking stressor. Also, an independent samples t test shows that after exposure to the stressor, the public speaking group had a significantly higher level of negative emotion compared to the exercise group. Before exposure to the stressor, there was no significant difference. Although, there was a reduction in negative emotion for the exercise group, it does not violate the premise of its use in the current project.

Positive emotions. For positive emotions, the repeated measures ANOVA revealed a significant multivariate time main effect, Wilks' $\Lambda = 0.75$, $F\ (1, 86) = 28.36$, $p < .05$, partial $\eta^2 = .25$. This analysis also revealed a significant multivariate time by stressor interaction, Wilks' $\Lambda = 0.93$, $F\ (1, 86) = 6.24$, $p < .05$, partial $\eta^2 = .07$. The main effect shows that positive emotions decreased over time from before participants were exposed to their arousal inductions to after.

To examine the significant interaction effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was made. As a result, the critical alpha was adjusted to .025. The interaction between stressor and time is disordinal and therefore the main effect should be qualified. First, a paired samples *t* test showed that for the exercise task, there was a small, but significant decrease in positive emotion from before exposure to the stressor (T_1) to after (T_3), $t\ (43) = 2.63$, $p < .01$, $d = .19$. A second paired samples *t* test showed that for the public speaking task, there was a much larger and significant decrease in positive emotion from before exposure to the stressor (T_1) to after (T_3), $t\ (43) = 4.64$, $p < .001$, $d = .52$. The means for the interaction are presented in Table 3. Positive emotions declined for both inductions, but the effect was larger for the public speaking group. Thus, although both arousal inductions reduced one's positive emotions, the public speaking stressor was more powerful in its ability to lower the positive emotions one experiences.

In summary, these manipulation check data indicate that the exercise task decreased both negative emotions and positive emotions. On the other hand, the public speaking stressor was successful in increasing negative emotions and decreasing positive emotions. The goal of the exercise task was to create an arousal induction that would not increase negative emotions, as would likely occur in the public speaking group. The decrease in negative emotion for the exercise group still meets this expectation. However, there was also a significant decrease in one's positive emotions in the exercise group. This was not intended; however, when coupled with the significant decrease in one's positive emotions for the public speaking group as well, this might indicate that an arousal induction might lower the positive emotions that a person experiences. On the other hand, not every arousal induction increases negative emotion.

Emotional Changes From Film Clips. In addition to the emotional changes created by the arousal inductions, the film clips used in the experimental procedures were also investigated for their success in affecting specific emotional changes. To test the emotional manipulation checks of the film clips, the emotion free film clip should not change a person's emotions. Further, the positive film clip should exhibit an increase in positive emotion and a decrease in negative emotion. Separate two-way within-subjects ANOVAs investigated the effectiveness of the emotion manipulations of the two film clips. Film clip (positive or no emotion) was a between subjects factor, time (before and after film clip exposure) was a within subjects factor and the two emotional factors (i.e., negative emotions, positive emotions) served as dependent variables. Two independent samples *t* tests show that before exposure to the film clip, there was no initial difference in negative emotion (d = .31), or positive emotion (d = .21), between the no emotion and positive emotion film clip groups (see Table 4).

Negative emotions. For the negative emotions factor, results of the repeated measures ANOVA revealed a significant time main effect at the multivariate level, Wilks' $\Lambda = 0.81$, $F(1, 86) = 20.34$, $p < .001$, multivariate partial $\eta^2 = .19$. The ANOVA did not reveal a significant time by film clip interaction effect at the multivariate level, Wilks' $\Lambda = 0.98$, $F(1, 86) = 1.77$, $p = .19$, multivariate partial $\eta^2 = .02$. Even though the interaction effect was not significant, the main effect needs to be probed, because the omnibus test tells nothing about whether both film clips significantly increased negative emotions.

To examine this main effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was made such that the critical alpha was adjusted to .025. First, a paired samples *t* test showed that for the no emotion film clip, there was a significant decrease in negative emotion from before exposure to the film clip (T_3) to after (T_5), $t(43) = 3.31$, $p < .01$, $d = .52$. A second paired samples *t* test showed that for the positive film clip, there was also a significant decrease in negative emotion from before exposure to the film clip (T_3) to after (T_5), $t(43) = 3.77$, $p < .001$, $d = .46$. The means for these tests can be found in Table 4. Both film clips reduced the amount of negative emotion participants experienced. This supported the expectation for the positive film clip and marginally supported the expectation for the no emotion film clip, because the latter was not supposed to effect any emotions.

Positive emotions. For the positive emotions factor, results of the repeated measures ANOVA revealed a significant time main effect at the multivariate level, Wilks' $\Lambda = 0.88$, $F(1, 86) = 12.33$, $p < .01$, multivariate partial $\eta^2 = .13$. However, the ANOVA did not reveal a significant time by film clip interaction effect at the multivariate level, Wilks' $\Lambda = 0.99$, $F(1, 86) = 1.24$, $p = .27$, multivariate partial $\eta^2 = .01$. Although the interaction effect was not significant, the main effect should be probed, because the omnibus test informs nothing regarding the specific effects.

To examine this main effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was performed such that critical alpha was adjusted to .025. First, a paired samples *t* test showed that for the no emotion film clip, there was no change in positive emotion from before exposure to the film clip (T_3) to after (T_5), $t(43) = -1.42$, $p = .16$, $d = .17$. A second paired samples *t* test showed that for the positive film clip, there was a significant increase, in positive emotion from before exposure to the film clip (T_3) to after (T_5), $t(43) = -4.34$, $p < .001$, $d = .35$. The means for these tests can be found in Table 4. These analyses showed the positive film clip was successful in increasing positive emotions and the exercise task did not have an effect on positive emotions.

In summary, these manipulation check data for the film clips show that the no emotion film clip decreased negative emotions, but did not increase any positive emotions in participants. On the other hand, the positive film clip was successful in decreasing negative emotions and increasing positive emotions. Ideally, the no emotion film clip should have resulted in no change in either negative or positive emotions. In addition, the positive film clip should have resulted in no change or a decrease in negative emotions and an increase in positive emotions. It was hoped that the no emotion film clip would have no effect on negative emotions. Even though the no emotion film clip decreased negative emotions, it did not have an effect on positive emotions. This allows the positive film clip to still be distinguishable from the negative film clip in terms of positive emotions.

Cardiovascular Changes From Arousal inductions. It was also necessary to ensure that the two arousal inductions were successful in increasing cardiovascular activity from baseline to immediately after the arousal inductions. To determine whether an increase in cardiovascular activity occurred as a result of each arousal induction task, four two-way repeated-measures ANOVAs were performed. Stressor (exercise or public speaking) was a between subjects factor, time (before and after stressor) was a within subjects factor and each of the four cardiovascular indicators (heart rate, mean arterial pressure, systolic blood pressure, diastolic blood pressure) were used as the dependent variables in the four tests outlined next.

In order to make sure that the arousal induction groups did not initially differ from one another on the four cardiovascular measures, baseline (i.e., T_1) assessments for the cardiovascular measures were initially examined. Independent samples *t* tests show that the two arousal inductions did not differ in terms of heart rate, t (86) = -1.20, p = .23, d = .26, mean arterial pressure, t (86) = -1.45, p = .15, d = .31, systolic blood pressure, t (86) = .02, p = .99, d = .004, or diastolic blood pressure, t (86) = -.93, p = .36, d = .20. This allows for the presumption that the two groups were roughly equal in terms of their baseline cardiovascular levels.

Heart rate. For heart rate, results of the repeated-measures ANOVA revealed a significant time main effect at the multivariate level, Wilks' Λ = 0.31, F (1, 86) = 188.23, $p < .001$, multivariate partial η^2 =.69. In addition, there was significant time by stressor interaction effect at the multivariate level, Wilks' Λ = 0.82, F (1, 86) = 19.11, $p < .001$, multivariate partial η^2 =.18. The main effect shows that heart rate increased from the baseline measurement (T_1) to the measurement taken immediately after exposure to the stressor (T_3). However, the difference was larger for the exercise group compared to the public speaking group.

To examine the interaction effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was made. As a result, the critical alpha was adjusted to .025. First, a paired samples *t* test showed that for the exercise arousal induction, there was a significant increase in heart rate before the stressor (T_1) to after (T_3), *t*

*(*43) = -11.29, $p < .001$, $d = 1.00$. A second paired samples *t* test showed that for the public speaking arousal induction, there was a significant increase in heart rate from before exposure to the stressor (T_1) to after (T_3), *t (*43) = -7.82, $p < .001$, $d = .62$. The means for these tests can be found in Table 5. This disordinal interaction effect renders the main effect uninterpretable. Compared to the public speaking group, the exercise group experienced a steeper increase in heart rate from before to after the stressor. The exercise group begins with a lower heart rate before exposure to the arousal induction, but finishes with a higher heart rate after exposure.

Mean arterial pressure. For mean arterial pressure (MAP), results of the repeated-measures ANOVA revealed a significant time main effect at the multivariate level, Wilks' $\Lambda = 0.93$, F (1, 86) = 6.18, $p < .05$, multivariate partial $\eta^2 = .07$. However, there was a nonsignificant time by stressor interaction effect at the multivariate level, Wilks' $\Lambda = 0.97$, F (1, 86) = 3.02, $p = .09$, multivariate partial $\eta^2 = .03$. Due to the significant omnibus test, the main effect will subsequently be examined so that the specific effects can be assessed. To examine this main effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was made. As a result, the critical alpha was adjusted to .025. First, a paired samples *t* test showed that for the exercise arousal induction, there was a significant increase in MAP from before exposure to the stressor (T_1) to after (T_3), *t (*43) = -3.07, $p < .01$, $d = .35$ (see Table 6). A second paired samples *t* test showed that for the public speaking arousal induction, there was no significant change in MAP from before exposure to the stressor (T_1) to after (T_3), t (43) = -.52, p = .31, d = .06.

The findings for MAP show that the only the exercise arousal induction was successful in increasing mean arterial pressure. That is, although the means increased, as expected, after exposure to the public speaking stressor, the difference is not large enough for us to conclude that this change is anything other than error. This means that any future statistical tests using MAP and involving the public speaking arousal induction need to be scrutinized. On the other hand, because MAP did significantly increase for the exercise group, future statistical tests involving these variables can offer insight into their relationship.

Systolic blood pressure. Systolic blood pressure results of the ANOVA revealed a significant time main effect at the multivariate level, Wilks' $\Lambda = 0.81$, F (1, 86) = 20.73, $p < .001$, multivariate partial $\eta^2 = .19$. In addition, there was a significant time by stressor interaction effect at the multivariate level, Wilks' Λ = 0.93, F (1, 86) = 6.63, $p < .05$, multivariate partial $\eta^2 = .08$ (see Table 7). The main effect shows that systolic blood pressure increased from the baseline measurement (T_1) to the measurement taken immediately after exposure to the stressor (T_3). However, the difference was larger for the exercise group compared to the public speaking group. This main effect is still interpretable because the interaction effect, which will be addressed next, it ordinal.

To examine the interaction effect, two planned comparisons were conducted. To account for inflated Type I error in these planned comparisons, a Bonferroni correction was made. As a result, the critical alpha was adjusted to

.025. First, a paired samples *t* test showed that for the exercise arousal induction, there was a significant increase in systolic blood pressure from before exposure to the stressor to after, t (43) = -4.63, $p < .001$, $d = .51$. A second paired samples *t* test showed that for the public speaking arousal induction, there was no significant change in systolic blood pressure from before exposure to the stressor (T_1) to after (T_3), t (43) = -.52, $p = .31$, $d = .17$. The interaction effect suggests that compared to the public speaking group, the exercise group experienced a steeper increase in systolic blood pressure from before (T_1) to after (T_3) the stressor. Both groups began with approximately the same mean, 114.39 versus 114.34; however, the exercise group finishes with a higher systolic blood pressure after exposure. This interaction effect renders the main effect still interpretable. Although, the main effects show that both arousal inductions increased in systolic blood pressure, this interaction effect suggests the exercise group's increase was statistically significant.

The findings for systolic blood pressure suggest that the public speaking group did not significantly experience an increase in systolic blood pressure, although the exercise arousal induction group did exhibit a significant increase. The means increased, as expected, after exposure to the public speaking stressor; however, it is not a large enough difference for us to conclude that this change is anything other than error. This means that any future statistical tests using systolic blood pressure and involving the public speaking arousal induction need to be carefully considered. On the other hand, because systolic blood pressure did significantly increase for the exercise group, future statistical tests involving these variables can offer insight into their relationship.

Diastolic blood pressure. Diastolic blood pressure results of the repeated measures ANOVA revealed a non significant time main effect at the multivariate level, Wilks' $\Lambda = 1.00$, $F\ (1, 86) = .28$, $p = .60$, multivariate partial $\eta^2 = .01$. Also, the ANOVA did not reveal a significant time by stressor interaction effect at the multivariate level, Wilks' $\Lambda = 1.00$, $F\ (1, 86) = .40$, $p = .53$, multivariate partial $\eta^2 = .003$. Therefore, there was no change of diastolic blood pressure over time, whether examined as a main effect or an interaction effect.

Summarizing the manipulation checks. Overall, there are three major manipulations checks that needed to be to performed to determine that the experimental inductions were successful. These manipulations included making sure: the arousal inductions effected participants' emotions in specific ways, the film clips effected emotions, and the arousal inductions increased cardiovascular activity. As predicted, the public speaking stressor, which was intended to evoke negative emotions, successfully increased negative emotions and decreased positive emotions. On the other hand, the exercise stressor, which was intended to effect no emotions, decreased a person's negative emotions and positive emotions. Although the positive emotions outcome was unexpected, this result does not indicate a failed manipulation. This is because even with the decrease in positive emotions, the exercise task is still an arousal induction successfully distinguishable from the public speaking task in terms of negative emotion.

The manipulation checks of the film clips also provided some unexpected findings. For instance, the no emotion film clip was chosen because in the pilot test, it had no effect on participants' emotions whatsoever. On the other hand, the positive film clip was chosen because in the pilot test, it enhanced the positive emotions experienced. The manipulation checks found that the no emotion film clip had no effect on positive emotions, but did lower the amount of negative emotions experienced. The positive film clip raised positive emotions and lowered negative emotions. Although, it makes it harder to distinguish the two film clips based on their effect on negative emotion, they are still differentiated in terms of their effects on positive emotions. Therefore, both film clips can still arguably be used to address the research questions.

Finally, the manipulation checks for the arousal inductions showed that there was marginal success in increasing the cardiovascular responses of participants in the exercise and public speaking groups. For the exercise group, there was a significant increase in three of the four measures of cardiovascular activity including heart rate, MAP, and systolic blood pressure. However, for the public speaking group, there was a significant increase for only the measure of heart rate. This is rather unfortunate, because the pilot test indicated that there would be more success in effecting cardiovascular activity than was accomplished in the main data collection. Although, it might seem that the only option is to address the research questions with heart rate and not use the other three measures of cardiovascular activity, I will subsequently include all four measures in the hope that they might still offer some insight into the role that positive emotions play in offsetting the deleterious effects of negative emotions.

Research Questions

To understand the research questions, it is helpful to recall that in this dissertation, positive emotions are manipulated through the use of a film clip. This film clip was confirmed in the pilot test and proved to be successful in increasing people's subjective assessment of their own positive emotions. As a result, any comprehension of the subsequent research questions requires the reader to know that when the term "positive emotions" is used, it is referring to the use of the positive film clip compared to the no emotion film clip.

The first research question asked if positive emotions undo the cardiovascular reactivity of an emotionally neutral stimulus. The second research question asked if the undoing of cardiovascular activity by the positive emotions film clip differs on whether participants' physiological arousal increase is due to a no-emotion arousal (exercise task) versus a negative emotional arousal (public speaking task).

To address the research questions, four separate repeated-measures ANOVAs were conducted to examine each cardiovascular measure (e.g., heart rate, mean arterial blood pressure, systolic blood pressure, and diastolic blood pressure). Stressor (exercise task and public speaking task), film clip (no emotion clip and positive emotion clip) and time (T_3 immediately after stress task, T_4 after partial film clip, T_5 after full film clip, and T_6 one minute after viewing film clip) were entered as the independent variables. Stressor and film clip are between subjects variables and time is a within subjects variable. Finally, the cardiovascular measures represented the dependent variables.

Heart rate. To test changes in heart rate, a 2 x 2 x 4 repeated measures ANOVA was conducted with stressor, film clip, and time as independent variables. Box's M test (48.79) was not significant (p = .04), indicating that there is no evidence of heterogeneity of the covariance matrices for heart rate across all between-subjects groups. Tabachnick & Fidell (2007) argue that Box's M is highly sensitive and therefore a more conservation alpha (.001) should be used. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, χ^2 (5) = 31.18, p < .001. Equal variances were not assumed for within-subjects factors and a Greenhouse-Geisser correction was applied. The multivariate tests will subsequently be used.

The main effect for time was significant, Greenhouse-Geisser adjusted F (2.35, 197.75) = 118.61, p < .001, multivariate partial η^2 = .59. The stressor by time interaction was also significant, Greenhouse-Geisser adjusted F (2.35, 197.75) = 16.09, p < .001, multivariate partial η^2 = .16. All other main and interaction effects were nonsignificant. An examination of the main effect required examining the heart rate measurements taken immediately after exposure to the stressor (T_3), after one minute of film clip (T_4), after the complete film clip (T_5), and one minute after the film clip (T_6) had been viewed. The main effect shows that heart rate scores decrease from T_3 to T_4, then they increase from T_4 to T_5, and finally, they decrease again from T_5 to T_6 (see Table 5).

An examination of the means indicated that the interaction was disordinal and the significant time main effect should be ignored. Therefore, I probed the interaction with a Bonferroni post hoc test. This entailed examining the differences between the heart rate measurements over time for each individual stressor (i.e., time within stressor simple main effects). For the exercise task, there was a significant decrease of heart rate between T_3 and T_4, a significant increase between T_4 and T_5, but there was no significant difference between T_5 and T_6. For the public speaking task, there was a significant decrease of heart rate between T_3 and T_4, a significant increase between T_4 and T_5, and a significant decrease of heart rate between T_5 and T_6.

Mean arterial pressure. To test changes in mean arterial pressure, a 2 x 2 x 4 repeated measures ANOVA was conducted with stressor, film clip, and time as independent variables and mean arterial pressure as the dependent variable. Box's M (36.77) was nonsignificant (p = .30) and therefore there is no evidence of heterogeneity of the covariance matrices of mean arterial pressure across all groups of the between-subjects factors. Mauchly's Test of Sphericity indicated that the assumption of sphericity was met, $\chi^2(5) = 8.84$, $p = .12$.

Examination of the repeated-measures ANOVA revealed a significant main effect of time, Wilks' $\Lambda = .68$, $F\ (3, 82) = 13.14$, $p < .001$, multivariate partial $\eta^2 = .33$. All other main and interaction effects were nonsignificant. From T_3 to T_6, MAP scores continued to decrease (see Table 6). For instance, this main effect showed that MAP decreased from T_3 to T_4, T_4 to T_5, and T_5 to T_6.

Systolic Blood Pressure. To test changes in systolic blood pressure, a 2 x 2 x 4 repeated measures ANOVA was conducted with stressor, film clip, and time as independent variables. Box's M (78.75) was significant ($p < .001$) and therefore there is evidence of heteroscedasticity of the covariance matrices of systolic blood pressure across all groups of the between-subjects factors. However, there are equal cell sizes and a reasonably large sample size of 88. Therefore, the ANOVA is robust to this violation (Field, 2009; Tabachnick & Fidell, 2007). Mauchly's Test of Sphericity indicated that the assumption of sphericity was met, $\chi^2(5) = 12.95$, $p = .02$. Therefore, equal variances were assumed for within subjects.

Results of the repeated-measures ANOVA indicated one main effect and one interaction effects on systolic blood pressure. First, there was a significant main effect of time, Wilks' $\Lambda = .58$, $F\,(3, 82) = 19.67$, $p < .001$, multivariate partial $\eta^2 = .42$. Further, there was a significant interaction effect for stressor by time, Wilks' $\Lambda = .88$, $F\,(3, 82) = 3.92$, $p < .05$, multivariate partial $\eta^2 = .13$. All other main and interaction effects were nonsignificant. First, the main effect will be examined and afterwards, the significant interaction effect will be discussed.

The main effect of time shows that from exposure to the stressor (T_3) to one minute after the film clip ended (T_6), systolic blood pressure scores continued to decrease at each minute interval. This included the systolic blood pressure measurement immediately after exposure to the stressor (T_3), after one minute of film clip (T_4), after the complete film clip (T_5), and one minute after the film clip

(T_6) had been viewed. For instance, this main effect showed that systolic blood pressure decreased from T_3 to T_4, T_4 to T_5, and T_5 to T_6 (see Table 7).

An examination of the means indicated that the interaction was disordinal and the significant time main effect should not be interpreted. Therefore, I probed the interaction with a Bonferroni post hoc test. This entailed examining the differences between the systolic blood pressure measurements over time for each individual stressor.

For the exercise arousal induction, results revealed that there was no difference in systolic blood pressure between T_3 and T_4, T_4 and T_5, nor T_5 and T_6; however, there was a significant decrease in systolic blood pressure from T_3 to T_6. This means that although there was no significant decrease at each interval, across the four systolic blood pressure measurements, there was a significant decrease for the exercise group. For the public speaking arousal induction, results revealed that there was no significant change between T_3 and T_4, a significant change between T_4 and T_5, and no significant change between T_5 and T_6. Further, there was no significant change between T_3 and T_6; however there was a significant decrease in systolic blood pressure between T_3 and T_5. By graphing the interaction between stressor and systolic blood pressure over time (from T_1 to T_6; see Figure 1), one can see that both arousal inductions show a comparable decrease of systolic blood pressure until T_6 when systolic blood pressure for the public speaking stressor group increases slightly above the final resting blood pressure measurement of the exercise stressor group.

Diastolic Blood Pressure. To test changes in diastolic blood pressure, a 2 x 2 x 4 repeated measures ANOVA was conducted with stressor, film clip, and time as independent variables. Box's M (68.34) was significant ($p < .001$) and therefore there is heteroscedasticity of the covariance matrices of diastolic blood pressure across all groups of the between-subjects factors. However, the ANOVA is robust to this violation, because there are equal cell sizes and a reasonably large sample size of 88. In addition, Mauchly's Test of Sphericity indicated that the assumption of sphericity was met, $\chi^2(5) = 10.16$, $p = .07$.

The main effect of time was significant, $F(3, 252) = 12.49$, $p < .001$, partial $\eta^2 = .13$. However, all other main and interaction effects were nonsignificant. The main effect of time shows that from T3 to T6, diastolic blood pressure scores continued to decrease at each minute interval. For instance, this main effect showed that diastolic blood pressure decreased from T_3 to T_4, T_4 to T_5, and T_5 to T_6 (see Table 8).

Chapter 4

DISCUSSION

In the previous chapter, the manipulation checks and the previous outcomes that resulted from the experiment were provided. In this chapter, I will summarize the emotional and cardiovascular results; subsequently, this will lead to a discussion of the theoretical and research implications of this study. Next, I will discuss the strengths and weaknesses of the study. Finally, I will provide several directions for future research suggested by this dissertation

Research Questions

This dissertation sought to gain insight into two research questions. These will be addressed ad seriatim. The first research question asked if positive emotions undo the cardiovascular reactivity of an emotionally neutral stimulus (i.e., the exercise task). In this dissertation, positive emotions were induced through a 100-second film clip that during the pilot test, showed an ability to increase the positive emotions that participants experienced. The comparison film clip entailed a man speaking to a second person who was stationed off camera. In the pilot test, participants who viewed this clip experienced no change in the relevant emotions. Therefore, this second film clip was considered a no emotion film clip.

Research question one. Whereas the second research question examined difference between the public speaking and exercise arousal inductions, the first research question examined only those changes in cardiovascular activity for the exercise group. For the first research question, if an effect of positive emotions existed in this study, there should be lower cardiovascular readings for those individuals who viewed the positive film clip compared to those individuals who viewed the no emotion film clip. Across the four cardiovascular dependent variables (e.g., heart rate, mean arterial pressure, systolic blood pressure, diastolic blood pressure), there were no significant main or interaction effects involving the film clip independent variable. Because the manipulation checks showed that the film clips were successful in the emotions they were meant to manipulate, the lack of effects suggests that the film clips did not differ in their ability to offset the increased cardiovascular activity resulting from the exercise task. That is, the positive and no emotion film clips, although they implicated the appropriate subjective emotional response, provided no difference in cardiovascular activity. This would imply that there is no effect of positive emotion on one's cardiovascular activity resulting from an emotion-free arousal induction (i.e., small amounts of exercise). However, this finding still has many implications for the undoing hypothesis of positive emotions, which will be discussed later in this chapter.

Research question two. The second research question asked if the undoing of cardiovascular activity by the positive emotions clip depends on whether participants' physiological arousal increase was due to a no-emotion arousal event (exercise task) versus a negative emotional event arousal (public speaking task). If there was no difference between the exercise and public speaking tasks regarding the amount of cardiovascular activity that occurred after positive emotions were induced, it could be argued that positive emotions are a successful tool for undoing heightened arousal, even when the increased arousal is not from a negative emotion-inducing event which brings about fear or anxiety. On the other hand, if there was a difference between the two arousal inductions regarding the amount of cardiovascular activity occurring after exposure to positive emotions, it could expose the nature of the undoing hypothesis for an array of arousal-inducing situations, not simply those preceding negative emotions.

The experiment in this dissertation was designed to address both research questions. However, the manipulation-check findings make it difficult to distinguish the two possibilities discussed in the previous paragraph and address the second research question at all. For instance, the fact that the two arousal inductions did not each cause a significant increase in cardiovascular activity at the same time (T_3) created a confounding problem. For the exercise group, three of the four cardiovascular measurements were significantly elevated by T_3. However, for the public speaking group, the only cardiovascular measurement that was still elevated at T_3 was heart rate. When examining whether there was a difference between the two arousal inductions at T_2 when the public speaking group experienced the peak increase, results indicated that all four measures of cardiovascular activity differed significantly from baseline for those in the public speaking group. Clearly, these results suggest that there was a very distinct difference when the two inductions experienced their respective surges in arousal. As a result of the discrepancy between the elevated arousal levels for the arousal inductions, the second research question cannot be answered.

It was hoped that the public speaking stress (i.e., arousal) would be highest when participants were planning in their heads what they were going to say for the speech (T_3). In order to keep the remainder of the experimental design in line with the timing of film clips and such, T_3 for both exercise and public speaking groups had to be examined. There was still an increase of heart rate at T_3 from baseline for the public speaking group, but none of the other three cardiovascular measures (mean arterial blood pressure, systolic blood pressure, and diastolic blood pressure) for the public speaking group were still significantly heightened by T_3. If I had looked at T_2 for the public speaking group (height of arousal) and T_3 for the exercise group (height of arousal), it would have shown an increase in cardiovascular activity to support the manipulation checks, but it would have thrown off the addressing of the second research question.

Even though the second research question was unable to be answered, I believe that this dissertation provides several implications for theory and research. This section will focus on addressing these two types of implications. To understand the theoretical implications of this dissertation, a small amount of time will be spent reviewing the theory and hypothesis upon which this study is based. First, the undoing hypothesis, upon which this dissertation is based, draws its predictions from a broader theoretical framework known as broaden and build theory of positive emotions.

Review of Theoretical Framework

A discussion of broaden and build theory must begin with a discussion of negative and positive emotions. For instance, life-threatening events typically result in negative emotions more often than positive ones. When there is a threat to one's livelihood, negative emotions surface and spark *specific thought-action tendencies*, because these emotions typically stem from life threatening events that require quick and specific decisions or actions for survival. On the other hand, not every emotion necessarily sparks a specific thought-action tendency. In the case of positive emotions, they likely arise absent of threats; therefore, no fast and committed decision or action is required for survival. If negative emotions narrow one's focus to specific urges that enhance immediate survival, it might be possible that the positive emotions that do not narrow action tendencies proceed along an alternative process. Broaden and build theory (Fredrickson, 1998; 2001) postulates that positive emotions expand the scope of one's attention and thought-action repertoires (Fredrickson & Branigan, 2005). This expansion of a person's behavioral scripts positions positive emotions better as *nonspecific thought-action tendencies*. Fredrickson (1998; 2003) claims that the effects of negative emotions are undone by positive emotions through the broadening of thought-action repertoires or tendencies.

Positive emotions cause a person's thought-action tendencies to broaden. As stated in Chapter 1, this arguably produces broader attention and cognitive mindsets. One of the ways that positive emotions broaden thought-action tendencies is by widening the way people think about and perceive information from their environments. When this cognitive broadening of one's mind occurs, it also opens up a range of benefits including social, intellectual, psychological, and physical resources. Physical resources include physical skills and health (Boulton & Smith, 1992; Danner, Snowdon, & Friesen, 2001).

If negative emotions narrow one's behaviors and this narrowing causes increased arousal that can be harmful over time, and positive emotions broaden one's behaviors, BBT argues that the reversing effect might include better health by offsetting the harmful negative effect addressed earlier in this dissertation. Given the research on the broadening effects of positive emotions, Fredrickson claims that positive emotions will also result in conferring certain health benefits or resources to individuals experiencing positive emotions. Further, by broadening a person's thought-action tendencies, positive emotions actually unwind the harmful heightened cardiovascular reactivity forced by negative emotions.

Within the boundaries of BBT, the undoing hypothesis (Fredrickson, 1998, Fredrickson & Levenson, 1998) argues that positive emotions themselves do not bring forth specific action tendencies or behaviors; therefore, they do not consequently require an increase in cardiovascular activity to carry out the behaviors. On the other hand, one reason positive emotions possibly exist is to subdue the cardiovascular response previously initiated by negative emotions (Fredrickson et al., 2000). Given the parameters of the undoing hypothesis, an initial state of arousal caused by the experience of negative emotions is necessary to support this effect of positive emotions (Levenson, 1988). Logistically, if negative emotions concentrate one's physiology (e.g., cardiovascular reactivity) for specific tendencies, positive emotions might undo this focus by hastening the return of one’s body to a less aroused state. Subsequently, this less aroused state would open up the variety of behavioral tendencies the individual might be inclined to pursue. Since prolonged physiological activity of negative emotions can have very harmful consequences to the human body, a less aroused state could be biologically advantageous. Given the undoing nature of positive emotions, Fredrickson et al. (2000) therefore argues that “positive emotions have a unique ability to down-regulate lingering negative emotions and the psychological and physiological preparation for specific action that they generate” (p. 240).

The undoing hypothesis of positive emotions (Fredrickson, 1998; 2000) is therefore built upon the idea that negative and positive emotions might balance each other. Manifestation of this relationship corresponds with a capacity to use positive emotions to help regulate the effects of negative emotions. Assuming the broadening of individuals’ thought-action repertoires by positive emotions, positive emotions should provide an antidote to negative emotions’ aftereffects. This counterweight means that positive emotions will broaden thought-action tendencies which might likely reverse the damaging effects of negative emotions (Fredrickson & Levenson, 1998; Khosla, 2006).

Implications for Theory and Research

Theoretical implications. The findings in this dissertation provide some implications for theory. Positive emotion was successfully manipulated through the film clip containing a tiny puppy playing with a large ball. In the pilot test, positive emotions associated with this clip were confirmed through the subjective emotional report of participants. That is, participants watched the clip and reported experiencing more positive emotions than before they were exposed to the clip. This was also confirmed in the main data collection. However, when this clip was shown to participants, it did not have an associated benefit of lower cardiovascular scores when compared to the no emotion film clip. Subsequently, the undoing hypothesis of positive emotions might be restricted to only certain positive emotions of which the film clip used in this dissertation failed to induce. This implies a gap between the subjective emotional report and the actual effect on one's physiology. Given the debate (Gendron, 2010; Izard, 2010; Landreth, 2010; Shiota, Neufeld, Yeung, Moser, & Perea, 2011; Stets, 2010; Tracy & Randles, 2011; Wierzbicka, 2010) regarding the ultimate nature of emotion, this dissertation suggests that a gap exists between appraisal of emotion and expected cardiovascular responses. In addition, broaden and build theory might be further restricted by the specific positive emotion being studied.

The undoing hypothesis of positive emotions, specified by Fredrickson (1998), states that the undoing effect of positive emotions works when put up against a backdrop of negative emotion. An examination of the answer to the first research question alone would support this conjecture because as was shown here, for those in the exercise group, there was no difference between the two film clips the degree to which they lowered participants' cardiovascular levels during the film clip, at the end of the film clip or even one minute after the film clip had been viewed. I argue this alone would support the claim that positive emotions only undo cardiovascular activity when it is the result of arousal brought on by negative emotions. However, upon examination of the second research question, which included the public speaking group along with the exercise group, there was one problem with investigating the requisite negative backdrop. The first problem, as already stated, involved the discrepancy of when the two arousal inductions experienced peak arousal. The lack of any effect involving the film clip independent variable cannot be identified as problematic, because we don't know that there should have been any difference between any of the main effect groups (e.g., exercise versus public speaking groups, no emotion film clip versus positive emotion film clip groups).

Research implications. In addition to the theoretical implications, there are many research implications of this study as well. First, future studies should include more than one positive emotion. This would allow claims regarding the effects of different positive emotions to be investigated. In this dissertation, it is unknown if there really was no difference between film clips in regard to cardiovascular activity or if the particular positive emotion film clip used in this dissertation tapped into one type of positive affect that was unsuccessful in lowering cardiovascular activity quicker than viewing an emotion-free film clip. Further, given that there was a slight cardiovascular increase immediately after both film clips ended, it is possible that the showing of the film clips kept participants physiological systems aroused longer than would have occurred absent of any film clip.

Also, given the absence of a difference between the two film clips one minute after the exercise task experienced their peak arousal and two minutes after the public speaking task experienced their peak arousal, some mechanism for judging cardiovascular differences under a minute would be useful. In a previous test of the undoing hypothesis of positive emotions, cardiovascular measures returned to baseline in an average of 30.08 seconds (*SD* = 25.80) in one sample and 37.78 seconds (*SD* = 35.88) in a second sample (Fredrickson et al., 2000). Therefore, one research implication of this dissertation is using the exercise task with equipment that allows for beat-by-beat measurement of cardiovascular activity. This way, it could be observed whether there was a difference, under one minute, between the exercise group that watched the positive emotion film clip and the exercise group that watched the no emotion film clip.

The last research implication could be examining the role of communication apprehension as a moderating variable. Not everyone is going to respond negatively to giving a speech. This dissertation did not assess to what degree participants experienced communication apprehension (McCroskey, 1977) or anxiety when it comes to public speaking. Given the public speaking task was used as an arousal induction, it would be helpful to know if there are differences between the two film clips when participants experience the highest levels of arousal because of their fear or anxiety for public speaking. In the current dissertation, the public speaking arousal induction post-test measure of negative emotions exhibited considerably more variation than the exercise group. This suggests some evidence that people tend to respond quite differently to this arousal induction compared to the exercise task. Therefore, including communication apprehension as a moderating variable would allow a test of the undoing hypothesis when the negative arousal induction was most likely to be high in negative emotions. Finally, using communication apprehension as a moderator will likely ensure that the public speaking fear task provides an even larger effect.

Strengths, Weaknesses, and Future Directions

This dissertation has a number of strengths and limitations based on its design. I will first discuss the strengths of the study. Next, I will address the limitations or weaknesses of this dissertation. Finally, I will discuss the directions for future research promoted by this dissertation.

Strengths. There are several strengths of this dissertation. These include the experimental design, the use of physiological data, its replication of original research, and the bipartite investigation of emotion. The experimental design of this study allowed for more control than would a survey alone. This control allowed the researcher to draw additional conclusions that would not otherwise have been possible. For instance, the experiment allows for an analysis of an entire social interaction over time. In addition, given the random assignment to conditions and use of baseline values of emotion and cardiovascular, the ability to address research questions was made with stronger internal validity.

The second strength, which involves the use of physiological data, is advantageous, because it gives insight into the biological underpinnings of stressful situations and mechanisms for reducing such stress. The third strength is that this study involves an attempt to replicate some of the original postulates of broaden and build theory, specifically the undoing hypothesis of positive emotions. Science is often described as being cumulative; however, a casual examination of academic journals shows a small amount of replications across researchers, institutions, and participants. The last strength of this dissertation is the bipartite analysis of emotion, which refers to the examination of subjective psychological self-reports of emotion and more objective physiological indicators of emotion. Given that a peer-reviewed academic journal, *Emotion,* recently spent an entire issue describing the nature and definition of emotion, the construct of emotion is nothing if not varied in conceptual definitions. This dissertation attempts to describe situations that raise arousal in terms of psychological and physiological dimensions which acknowledges the various viewpoints that might further future discussion of this broad concept.

Limitations. No study is without its faults and this one had several. First, although the sample homogeneity may be advantageous for purposes of internal validity, it limits to whom the findings of this dissertation can be extended. For instance, the sample was relatively similar in terms of age, education, ethnicity, and positive health. Second, participants were screened for normal blood pressure, smoking, chemotherapy or chest radiation, history of hepatitis, endocrine disease, rheumatologic disorders, respiratory problems or diabetes, heart attack, cardiac arrhythmias, heart disease and reported use of steroids. However, this screening consisted of a self-report survey. Participants may have been untruthful in their assessment of their own behaviors and this subsequently may have led to false information that effected results.

The next limitation involves the lack of sophisticated equipment to assess short-term changes in cardiovascular activity. For instance, in the original Fredrickson studies (Fredrickson & Levenson, 1998; Fredrickson et al., 2000), they utilized an Ohmeda Finapres Blood Pressure Monitor (Model 2300), which allowed for beat-by-beat assessments of cardiovascular activity. In this current dissertation, the available equipment only allowed for measurements at one-minute intervals. Any changes occurring within a minute might have been missed or undetected.

Finally, the last limitation is that there was a flaw in the timing of the peak arousal for two arousal induction conditions. For the public speaking group, what occurred was that the height of the arousal was immediately after the instructions (T_2), whereas, for the exercise group, the height of physiological arousal was after participants stopped stepping up and down on a step stool (T_3). I intended to have both conditions experience the peak in arousal after the instructions, not during the instructions.

Future Directions. This dissertation suggests several future directions that might result from the work done within this study. First, although this dissertation used the threat of giving a public speech to evoke the emotions of fear and anxiety, some participants may not have been convinced that they would actually have to give a speech. As a result, a future direction for this research might include a real public speaking situation. Participants could be attached to the cardiovascular measuring equipment and arousal increases could be assessed for those participants who are asked to give an actual speech. This inclusion of impromptu speaking as the experimental task can be helpful because impromptu speaking is ubiquitous and any insight into the physiological effects of this speaking context might enable researchers to find ways to offset the stress resulting from it. This might help to ensure that the manipulation works for a longer period of time. Then positive emotions can be introduced immediately during the experience of fear. Communication apprehension refers to the “fear or anxiety associated with either real or anticipated communication with another person or persons” (Richmond & McCroskey, 1998, p. 51). Future research might focus on only those individuals high in communication apprehension, because the public speaking arousal induction might work more successfully due to the arousal created by the individual’s fear of speaking.

Another future direction might involve the use of additional film clips with actual sound. Although sound was removed from each condition in order to reduce the number of alternative explanations for any findings, watching television or film without sound is unnatural for most college students. Media studies scholars might find it helpful to use a variety of media clips in an effort to effect human cardiovascular activity.

In addition to what has already been stated, another direction for future research might involve additional physiological equipment or a look at different physiological systems. For instance, the lack of a mechanism for judging beat-by-beat assessments of cardiovascular activity was a discussed weakness that should be eliminated. Give that the changes in cardiovascular activity as a result of the film clips could have occurred between the one minute intervals used in this dissertation, additional and more sophisticated equipment could determine if there is a significant change within the first minute of watching a positive emotion versus an emotion free film clip.

Also, an examination of different physiological systems could shed additional light onto the biological changes that occur when observing emotionally-charged film clips. For instance, those interested in the endocrine system might examine the difference in the amount of stress hormones (e.g., cortisol) secreted after exposure to a stressor and again after the experience of positive emotions versus other emotions. In addition to cortisol, one might examine the secretion of adrenaline (and inversely norepinephrine) based on the type of stressor (psychological/communicative versus physiological) to which one is exposed. Given that research shows norepinephrine is released in response to acute psychosocial stress (Wirtz, Siegrist, Rimmele, & Ehlert, 2008), more research regarding this catecholamine should be investigated. For instance, this hormone might be responsible for the spike in mean arterial pressure and diastolic blood pressure that the public speaking group experienced, which however, the exercise group did not. Although the exercise and public speaking groups experienced equitable increases in heart rate and systolic blood pressure, norepinephrine might have been released more so in the public speaking arousal, which accounted for the larger increases of mean arterial pressure and diastolic blood pressure. Norepinephrine might have been elevated for the speaking group but not the exercise group, because of the psychosocial threat in the speaking task.

This could be investigated through an analysis of the endocrine, instead of the cardiovascular, system.

Those interested in brain mapping might investigate the neural connections made from exposure to a stressor until the experience of positive emotions. Additionally, an examination of the galvanic skin response is better suited for assessing nervous system activity after a psychological stressor compared to a physiological one like exercise because the latter is already likely to create a ceiling effect in the amount of perspiration or sweating that might occur (Buckworth & Dishman, 2002).

Finally, judging how positive a film clip might be based on subjective emotional report alone is problematic as participants have more control over how they want to present themselves to a researcher. This social desirability or biased effect might confuse assessments of what emotions people claim they are experiencing. However, researchers interested in facial musculature might be able to use a variety of tools to assess the emotions participants are experiencing. For instance, another form of subjective measurement in addition to the use of an emotion self-report would be use of independent coders who can code facial expressions using something akin to the Facial Action Coding System (FACS; Ekman & Friesen, 1978) or the Specific Affect Coding System (SPAFF; Coan & Gottman, 2007). This research could be used to determine the emotions that participants' experience during the arousal induction or during the film clip viewing.

Another mechanism for judging emotions involves the use of electromyography (EMG) to assess facial muscle movement. Because the electrodes that are placed on the face during EMG are so sensitive, they can detect very minuscule muscle movements. This objective method allows for researchers to see not just which muscles are activated, but also the strength of duration of the muscle contraction. This level of specificity helps researchers determine the nuances of the emotional experience that might accompany any form of subjective self-report assessments.

Finally, this dissertation chose to analyze a specific area of communication, which involved public speaking anxiety. However, other areas of communication or communication tasks might also be relevant. Conflict communication scholars could replace the public speaking stressor in this dissertation with some type of conflict episode and then see if the experience of positive emotions attenuates the conflict or the stress resulting from it.

REFERENCES

AAMI. (1987). *American national standard for electronic or automated sphygmomanometers*. Arlington, VA: Association for the Advancement of Medical Instrumentation.

AAMI. (1993). *American national standard for electronic or automated sphygmomanometers*. Arlington, VA: Association for the Advancement of Medical Instrumentation.

Aron, A., Norman, C. C., Aron, E.N., McKenna, C., & Heyman, R. (2000). Couples shared participation in novel and arousing activities and experienced relationship quality. *Journal of Personality and Social Psychology, 78*, 273-283.

Bouchard, C., Blair, S. N., Church, T. S., Earnest, C.P., Hagberg, J.M., Hakkinen, K…Rankinen, T. (2012). Adverse metabolic response to regular exercise: Is it a rare or common cccurrence? *PLoS ONE, 7(5),* e37887. doi:10.1371/journal.pone.0037887

Boulton, M. J., & Smith, P. K. (1992). The social nature of play fighting and play chasing: Mechanisms and strategies underlying cooperation and compromise. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 429-450). New York: Oxford University Press.

Bradley, M. M., Miccoli, L., Escrig, M. A., & Lang, P. J. (2008). The pupil as a measure of emotional arousal and autonomic activation. *Psychophysiology, 45*, 602–607. doi: 10.1111/j.1469-8986.2008.00654.x

Buckworth, J., & Dishman, R. K. (2002). Exercise psychology. Champaign, IL: Human Kinetics Publishers.

Cacioppo, J. T., Klein, D. J., Berntson, G. G., & Hatfield, E. (1993). The psychophysiology of emotion. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (119-142). New York: Guilford Press.

Carnevale, P. J., & Isen, A. M. (1986). The influence of positive affect and visual access on the discovery of integrative solutions in bilateral negotiation. *Organizational Behavior and Human Decision Processes, 37(1),* 1–13.

Coan, J. A., & Gottman, J. M. (2007). The specific affect (SPAFF) coding system. In J. A. Coan and J. J. B. Allen (Eds.), *Handbook of emotion elicitation and assessment* (pp. 106-123). New York: Oxford University Press.

Cohen, S., Tyrrell, D. A. J., Smith, A. P., (1991). Psychological stress and susceptibility to the common cold. *New England Journal of Medicine, 325*, 606-612.

Cohn, M. A., & Fredrickson, B. L. (2006). Beyond the moment, beyond the self: Shared ground between selective investment theory and the broaden-and-build theory of positive emotions. *Psychological Inquiry, 17*, 39-44.

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment Research & Evaluation, 10(7),* 1-9.

Crawford, A. V., Green, S. B., Levy, R., Lo, W. J., Scott, L., Svetina, D., & Thompson, M. S. (2010). Evaluation parallel analysis methods for determining the number of factors. *Educational and Psychological Measurement, 70*, 885-901.

Csikszentmihalyi, M., & Rathunde, K. (1998). The development of the person: An experiential perspective on the ontogenesis of psychological complexity. In W. Damon (Series Ed.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (5th ed., pp. 635-684). New York: Wiley.

Danner, D., Snowdon, D., & Friesen, W. (2001). Positive emotion in early life and longevity: Findings from the nun study. *Journal of Personality and Social Psychology, 80,* 804-813.

Denson, T. F., Spanovic, M., & Miller, N. (2009). Cognitive appraisals and emotions predict cortisol and immune responses: A meta-analysis of acute laboratory social stressors and emotion inductions. *Psychological Bulletin, 135,* 823–853.

Ekman, P. (1992). An argument for basic emotions. *Cognitions and Emotion, 6*, 169-200.

Ekman, P. (1994). Are there basic emotions: All emotions are basic. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 15-19). Oxford: Oxford University Press.

Ekman, P., &.Friesen, W. V. (1974). Detecting deception from the body or face. *Journal of Personality and Social Psychology, 29,* 288-298.

Ekman, P., Friesen, W. V., & Ancoli, S. (1980). Facial signs of emotional experience *Journal of Personality and Social Psychology*, *39,* 1125-1134.

Ekman, P., Friesen, W. V., O'Sullivan, M., Chan, A., Diacoyanni-Tarlatzis, I., Heider, K., … Tzavaras, A. (1987). Universals and cultural differences in the judgments of facial expressions of emotion. *Journal of Personality and Social Psychology, 53(4)*, 712-717.

Fazio, R. H., Eiser, J. R., & Shook, N. J. (2004). Attitude formation through exploration: Valence asymmetries. *Journal of Personality and Social Psychology, 87*, 293-311.

Feldman, P. J., Cohen, S., Hamrick, N., & Lepore, S. J. (2004). Psychological stress, appraisal, emotion and cardiovascular response in a public speaking task. *Psychology and Health, 19*, 353-368.

Floyd, K., Mikkelson, A. C., & Hesse, C. (2008). *The biology of human communication (2nd ed.)*. Florence, KY: Thomson Learning.

Folkman, S., & Moskowitz, J. T. (2000). Positive affect and the other side of coping. *American Psychologist, 55(6),* 647-654.

Frederickson, B. L. (2001). The role of positive emotions in positive psychology. *American Psychologist, 56(3)*, 218-226.

Fredrickson, B. L. (1998). What good are positive emotions? *Review of General Psychology, 2*, 300-319.

Fredrickson, B. L. (2003). The value of positive emotions: The emerging science of positive psychology is coming to understand why it's good to feel good. *American Scientist, 91*, 330-335.

Fredrickson, B. L. (2009). *Positivity*. New York: Crown Publishers.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion, 19*, 313-332.

Fredrickson, B. L., & Joiner, T. E. Jr. (2002). Positive emotions trigger upward spirals toward emotional well-being. *Psychological Science, 13(2)*, 172–175.

Fredrickson, B. L., & Levenson, R. W. (1998). Positive emotions speed recovery from the cardiovascular sequelae of negative emotions. *Cognition and Emotion, 12*, 191-220.

Fredrickson, B. L., & Losada, M. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist, 60,* 678–686.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open hearts build lives: Positive emotions, induced through lovingkindness meditation, build consequential personal resources. *Journal of Personality and Social Psychology, 95*, 1045-1062.

Fredrickson, B. L., Mancuso, R. A., Branigan, C., & Tugade, M. M. (2000). The undoing effect of positive emotions. *Motivation and Emotion, 24*, 237-258.

Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Larkin, G. R. (2003). What good are positive emotions in crisis? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology, 84(2),* 365-376.

Fridja, N. (1993). Moods, emotions episodes and emotions. In M. Lewis & I. Haviland (Eds.), *Handbook of emotions* (pp. 381-403). Guildford: New York.

Frijda, N.H. (1986). *The Emotions.* Cambridge: Cambridge University Press.

Frijda, N.H., Kuipers, P., & Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology, 57,* 212-228.

Gendron, M. (2010). Defining emotion: A brief history. *Emotion Review, 2*, 371-371.

Goldkind, S. F., Sahin, L., & Gallauresi, B. (2010). Enrolling pregnant women in research: Lessons from the H1N1 influenza pandemic. *New England Journal of Medicine, 362(24)*, 2241-2243.

Guerrero, L. K., & Andersen, P. A. (2000). Emotion in close relationships. In C. Hendrick & S. S. Hendrick (Eds.), *Close relationships: A sourcebook* (pp. 171-184). Thousand Oaks, CA: Sage.

Hadany, L., Beker, T., Eshel, I., & Feldman, M. (2006). Why is stress so deadly? An evolutionary perspective. *Proceedings of the Royal Society B: Biological Sciences, 273(1588)*, 881-885.

Hayton, J. C., Allen, D. G., Scarpello, V. (2004). Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis. *Organizational Research Methods, 7*, 191-205.

Herbert, T. B., & Cohen, S. (1993). Stress and immunity in humans: A meta-analytic review. *Psychosomatic Medicine, 55*, 364-379.

Hinkle, L. E. (1987). Stress and disease: The concept after 50 years. *Social Science & Medicine, 25*, 561-566.

Isen, A. M. (1987). Positive affect, cognitive processes, and social behavior. *Advances in Experimental Social Psychology, 20*, 203-253.

Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. Journal of *Personality and Social Psychology, 47*, 1206-1217.

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology, 52*, 1122-1131.

Isen, A. M., Johnson, M. M. S., Mertz, E., & Robinson, G. F. (1985). The influence of positive affect on the unusualness of word associations. *Journal of Personality and Social Psychology, 48*, 1413-1426.

Isen, A. M., Niedenthal, P., & Cantor, N. (1992). The influence of positive affect on social categorization. *Motivation and Emotion, 16*, 65-78.

Isen, A. M., & Levin, P. F. (1972). The effect of feeling good on helping: Cookies and kindness. *Journal of Personality and Social Psychology, 21*, 384-388.

Izard, C. E. (2010). The many meanings/aspects of emotion: Definitions, functions, activation, and regulation. *Emotion Review, 2,* 363-370.

Johnson, K. J., & Fredrickson, B. L. (2005). We all look the same to me. *Psychological Science, 16(11)*, 875-881.

Johnston, V. S. (1999). *Why we feel? The science of human emotions*. Reading, MA: Helix Books.

Izzo, J., Levy, D., & Black, H. R. (2000). Clinical advisory statement. Importance of systolic blood pressure in older Americans. *Hypertension, 35(5)*, 1021-1024.

Kemeny, M. E. (2003). The psychobiology of stress. *Current Directions in Psychological Science, 12(4)*, 124-129.

Khosla, M. (2006). Positive affect and coping with stress. *Journal of the Indian Academy of Applied Psychology, 32*, 185-192.

Kiecolt-Glaser, J. K., McGuire, L., Robles, T., & Glaser, R. (2002). Psychoneuroimmunology: Psychological influences on immune function and health. *Journal of Consulting and Clinical Psychology, 70,* 537-547.

Kok, B. E., Catalino, L. I., & Fredrickson, B.L. (2008). The broadening, building, buffering effects of positive emotions. In S. J. Lopez (Ed.), *Positive* *psychology: Exploring the best of people: Vol. 3 Capitalizing on emotional experiences.* (pp. 1-19). Westport, CT: Greenwood Publishing Company.

Kop, W. J., Synowski, S. J., Newell, M. E., Schmidt, L. A., Waldstein, S. R., & Fox, N. A. (2011). Autonomic nervous system reactivity to positive and negative mood induction: The role of acute psychological responses and frontal electrocortical activity. *Biology Psychology, 86(3)*, 230-238.

Landreth, A. (2010). Confusion, cost, and emotion research. *Emotion Review, 2*, 373-374.

Lee, P. C. (1983). Play as a means for developing relationships. In R. A. Hinde (Ed.), *Primate social relationships* (pp. 82–89). Oxford: Blackwell.

Leslie, A. M. (1987). Pretense and representation: The origins of ``theory of mind''. *Psychological Review, 94*, 412-426.

Levenson, R.W. (1988). Emotion and the autonomic nervous system: A prospectus for research on autonomic specificity. In H.L. Wagner (Ed.), *Social psychophysiology and emotion: Theory and clinical applications* (pp. 17- 42). London: Wiley.

Levenson, R.W. (1992). Autonomic nervous system differences among emotions. *Psychological Science, 3,* 23-27.

Levenson, R.W. (1994). Human emotion: A functional view. In P. Ekman & R. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 123-126)*.* New York: Oxford University Press.

Levenson, R.W., Ekman, P., & Friesen, W.V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27*, 363-384.

Maddox, T. M., Ross, C., Ho, P. M., Magid, D., & Rumsfeld, J. S. (2009). Impaired heart rate recovery is associated with new-onset atrial fibrillation: A prospective cohort study. *BMC Cardiovascular Disorders, 9(11),* 1-6.

McCroskey, J. C. (1977). Oral communication apprehension: A summary of recent theory and research. *Human Communication Research, 4*, 78-96.

McCroskey, J. C., & Young, T. J. (1979). The use and abuse of factor analysis in communication research. *Human Communication Research, 5*, 375-382.

Morise, A. P. (2004). Heart rate recovery and impact of myocardial revascularization on long-term mortality. *Circulation, 110*, 2778-2780.

Murstein, B. I. (1986). *Paths to Marriage*. Newbury Park, CA: Sage.

Nesse, R. M. (1990). Evolutionary explanations of emotions. *Human Nature, 1*, 261-289.

Olatunji, B., & Sawchuk, C. (2005). Disgust: Characteristic features, social manifestations, and clinical implications. *Journal of Social and Clinical Psychology, 24(7)*, 932–962.

Osborne, J. W., & Costello, A. B. (2009). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Pan-Pacific Management Review, 12(2),* 131-146. Reprint of Costello & Osborne (2005).

Ekman, P., & Friesen, W. (1978). *Facial action coding system: A technique for the measurement of facial movement*. Palo Alto, CA: Consulting Psychologists Press.

Panksepp, J. (1998). Attention deficit hyperactivity disorders, psychostimulants, and intolerance of childhood playfulness: A tragedy in the making? *Current Directions in Psychological Science, 7*, 91-98.

Pratto, E., & John, O. E. (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61*, 380-391.

Richmond, V. P., & McCroskey, J. C. (1998). *Communication: Apprehension, avoidance, and effectiveness* (5th Ed.). Boston, MA: Allyn.

Pastor-Barriuso, R., Banegas, J. R., Damián, J., Appel, L. J., Guallar, E. (2003). Systolic blood pressure, diastolic blood pressure, and pulse pressure: An evaluation of their joint effect on mortality. *Annals of Internal Medicine, 139(9)*, 731-739.

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*, 23-41.

Sapolsky, R. M. (2004). *Why zebras don't get ulcers*. New York: Holt Paperbacks.

Schachter, S. (1964). The interaction of cognitive and physiological determinants of emotional state. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 1, pp. 49-80). New York: Academic Press.

Scherer, K. R. (1994). Toward a concept of "modal emotions." In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 25–31). New York: Oxford University Press.

Segerstrom, S., & Miller, G. (2004). Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. *Psychological bulletin, 130(4)*, 601.

Selye, H. (1950). Stress and the general adaptation syndrome. *British Medical Journal, 4667*, 1383-1392.

Selye, H. (1976). Forty years of stress research: principal remaining problems and misconceptions. *Canadian Medical Association Journal, 115*, 53-56.

Shiota, M. N., Neufeld, S. L., Yeung, W. H., Moser, S., & Perea, E. F. (May, 2010). *Differential autonomic nervous system responding in five positive emotions.* Paper presented at the Boston, Massachusetts 2010 meeting of the Association for Psychological Science.

Stets, J. E. (2010). Future directions in the sociology of emotions. *Emotion Review, 2*, 265-268.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using Multivariate Statistics*. Boston: Allyn and Bacon.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using Multivariate Statistics, 5th ed.* Boston: Allyn and Bacon.

Thayer, J. F., Hansen, A. L., & Johnsen, B. H. (2008). Non-invasive assessment of autonomic influences on the heart: Impedance cardiography and heart rate variability. In L. J. Luecken & L. C. Gallo (Eds.), *Handbook of physiological research methods in health psychology* (183-209). Newbury Park, CA: Sage Publications.

Tomkins, S. S. (1962). *Affect, imagery, consciousness, Vol. 1: The positive affects*. New York: Springer.

Tracy, J. L., & Randles, D. (2011). Four models of basic emotions: A review of Ekman and Cordaro, Izard, Levenson, and Panksepp and Watt. *Emotion Review, 3*, 397-405.

Wadlinger, H.A., & Isaacowitz, D. M. (2006). Positive mood broadens visual attention to positive stimuli. *Motivation and Emotion, 30,* 89-101.

Waugh, C. E., & Fredrickson, B. L. (2006). Nice to know you: Positive emotions, self–other overlap, and complex understanding in the formation of a new relationship. *The Journal of Positive Psychology, 1*, 93-106.

White, G. L., & Kight, T. D. (1984). Misattribution of arousal and attraction: Effects of salience of explanations for arousal. *Journal of Experimental Social Psychology, 20*, 55-64.

Wierzbicka, A. (2010). A "history of emotions" and the future of emotion research. *Emotion Review, 2*, 269-273.

Wirtz, P. H., Siegrist, J., Rimmele, U., & Ehlert, U. (2008). Higher overcommitment to work is associated with lower norepinephrine secretion before and after acute psychosocial stress in men. Psychoneuroendocrinology, 33, 92-99.

Table 1

Description of cardiovascular (CV) measurements

CV Measurements	Time	Description	Included in Analyses?
Measurement 1	--	Baseline 1	No
Measurement 2	Time 1 (T_1)	Baseline 2	Yes
Measurement 3	Time 2 (T_2)	After Instructions	Yes
Measurement 4	Time 3 (T_3)	After Stressor	Yes
Measurement 5	Time 4 (T_4)	After 1 min. film clip	Yes
Measurement 6	Time 5 (T_5)	After full film clip	Yes
Measurement 7	Time 6 (T_6)	1 minute after film clip	Yes
Measurement 8	--	2 minutes after film clip	No

Table 2

Structure matrix factor loadings for subjective emotional reports

Variable Label	Negative Emotions	Positive Emotions
Pained	**.78**	.15
Anger	**.71**	.10
Fear	**.57**	.23
Sadness	**.57**	.05
Surprise	.44	.35
Disgust	.36	.07
Happiness	.07	**.85**
Interest	.13	**.78**
Arousal	.21	.48

Notes. Extraction Method: Principal Axis Factoring. Rotation Method: Oblimin with Kaiser Normalization

Table 3

Emotion changes for arousal inductions

Arousal Inductions	Exercise Group	Public Speaking Group	Difference
Negative Emotions			
(T_1) Before Stressor	.45 (.79)	.44 (.68)	*t(86)* =-.07
(T_3) After Stressor	.27 (.60)	1.07 (1.32)	*t(60.26)* =-3.68*
Positive Emotions			
(T_1) Before Stressor	4.68 (1.77)	4.81 (1.65)	*t(86)* -.37
(T_3) After Stressor	4.34 (1.88)	3.87 (1.97)	*t(86)* =1.14

Note. p < . 05. The Difference column tests for the difference between the two arousal inductions before and after exposure to the arousal induction.

Table 4

Emotion changes for film clips

Film Clips	"No Emotion"	Positive Emotion	Difference
Negative Emotions			
(T_3) Before film clip	.81 (1.33)	.52 (.75)	*t(86) =1.28*
(T_5) After film clip	.27 (.59)	.22 (.59)	*t(86) =.40*
Positive Emotions			
(T_3) Before film clip	3.90 (1.98)	4.31 (1.87)	*t(86)* =-.97
(T_5) After film clip	4.24 (2.02)	4.94 (1.82)	*t(86)* =-1.72*

Note. p < . *05.* The Difference column tests for the difference between the two film clips before and after exposure to the film clips.

Table 5

Heart rate means (and standard deviations) for arousal inductions

	Exercise Group	Public Speaking Group	Total	Difference
HR				
Time 1	76.32 (15.32)$_{bc}$	79.91 (12.61)$_{a}$	78.11 (14.07)	$t(86)$ =-1.20
Time 2	81.98 (16.71)$_{a}$	94.20 (15.28)$_{b}$	88.09 (17.07)	$t(86)$ =-3.58*
Time 3	92.59 (17.25)$_{d}$	88.32 (14.33)$_{c}$	90.45 (15.91)	$t(86)$ =1.26
Time 4	73.66 (16.30)$_{b}$	79.23 (13.95)$_{a}$	76.44 (15.34)	$t(86)$ =-1.72
Time 5	78.57 (15.34)$_{ac}$	83.57 (13.58)$_{d}$	81.07 (14.62)	$t(86)$ =-1.62
Time 6	76.27 (16.19)$_{bc}$	80.14 (13.10)$_{a}$	78.20 (14.77)	$t(86)$ =-1.23

Note. *p < .05. The Difference column tests for the difference between the two arousal inductions at each time. The Total column represents the mean for that measurement across both groups. Within each arousal induction group, scores with different subscripts differ at p < .05 using a Bonferroni adjustment.

Table 6

Mean arterial pressure (MAP) means (and standard deviations) for arousal inductions

	Exercise Group	Public Speaking Group	Total	Difference
MAP				
Time 1	83.11 (8.22)$_{abc}$	85.64 (8.10)$_{ab}$	84.38 (8.21)	*t(86)* =-1.45
Time 2	84.18 (6.49)$_{abc}$	91.73 (10.18)$_{c}$	87.95 (9.30)	*t(86)* =-4.15*
Time 3	86.07 (8.83)$_{a}$	86.16 (8.98)$_{a}$	86.11 (8.85)	*t(86)* =-.05
Time 4	84.25 (8.77)$_{ab}$	84.82 (7.58)$_{ab}$	84.53 (8.16)	*t(86)* =-.33
Time 5	82.64 (8.23)$_{bc}$	83.25 (7.72)$_{b}$	82.94 (7.94)	*t(86)* =-.36
Time 6	81.39 (7.64)$_{c}$	83.41 (7.31)$_{b}$	82.40 (7.50)	*t(86)* =-1.27

Note. *$p < .05$. The Difference column tests for the difference between the two arousal inductions at each time. The Total column represents the mean for that measurement across both groups. Within each arousal induction group, scores with different subscripts differ at $p < .05$ using a Bonferroni adjustment.

Table 7

Systolic blood pressure means (and standard deviations) for arousal inductions

	Exercise Group	Public Speaking Group	Total	Difference
SYS				
Time 1	114.39 (13.18)$_{bc}$	114.34 (11.93)$_{a}$	114.36 (12.50)	$t(86)$ =.02
Time 2	113.86 (14.12)$_{bc}$	123.05 (12.28)$_{b}$	118.45 (13.94)	$t(86)$ =-3.26*
Time 3	122.00 (16.29)$_{a}$	116.45 (12.36)$_{a}$	119.23 (14.64)	$t(86)$ =1.80
Time 4	117.98 (11.56)$_{ab}$	116.09 (12.25)$_{a}$	117.03 (11.88)	$t(86)$ =.74
Time 5	114.57 (11.27)$_{bc}$	112.16 (11.93)$_{a}$	113.36 (11.60)	$t(86)$ =.97
Time 6	111.68 (10.84)$_{c}$	112.95 (12.27)$_{a}$	112.32 (11.53)	$t(86)$ =-.52

Note. *$p < .05$. The Difference column tests for the difference between the two arousal inductions at each time. The Total column represents the mean for that measurement across both groups. Within each arousal induction group, scores with different subscripts differ at $p < .05$ using a Bonferroni adjustment.

Table 8

Diastolic blood pressure means (and standard deviations) for arousal inductions

	Exercise Group	Public Speaking Group	Total	Difference
DIAS				
Time 1	67.57 (6.53)$_a$	68.93 (7.22)$_a$	68.25 (6.88)	$t(86)$ =-.93
Time 2	67.44 (7.37)$_{ab}$	74.00 (9.14)$_c$	70.76 (8.90)	$t(86)$ =-3.68*
Time 3	68.36 (8.93)$_a$	68.86 (7.00)$_a$	68.61 (7.99)	$t(86)$ =-.29
Time 4	66.30 (8.10)$_{ab}$	68.07 (7.42)$_a$	67.18 (7.77)	$t(86)$ =-1.07
Time 5	65.30 (7.55)$_{ab}$	66.59 (6.79)$_{ab}$	65.94 (7.17)	$t(86)$ =-.85
Time 6	64.18 (7.01)$_b$	65.34 (7.19)$_b$	64.76 (7.08)	$t(86)$ =-.77

*Note. *p < .05.* The Difference column tests for the difference between the two arousal inductions at each time. The Total column represents the mean for that measurement across both groups. Within each arousal induction group, scores with different subscripts differ at $p < .05$ using a Bonferroni adjustment.

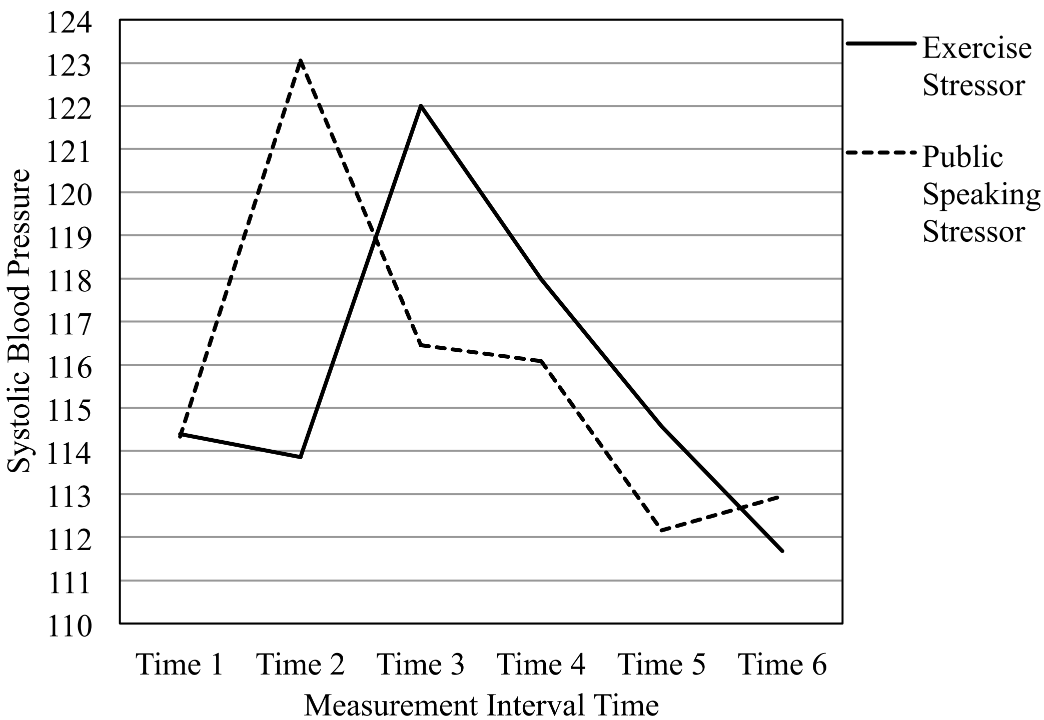

Figure 1. *Interaction effects on systolic blood pressure for stressor by time*

APPENDIX A

HUMAN SUBJECTS APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Kory Floyd STAUF
From:	Carol Johnston, Chair Biosci IRB
Date:	03/02/2012
Committee Action:	**Expedited Approval**
Approval Date:	03/02/2012
Review Type:	Expedited F4 F7
IRB Protocol #:	1202007535
Study Title:	An Experimental Replication and Refinement of the Undoing Hypothesis of Positive Emotions
Expiration Date:	03/01/2013

The above-referenced protocol was approved following expedited review by the Institutional Review Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Institutional Review Board.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Biosci IRB immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Biosci IRB. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

APPENDIX B

ONLINE SURVEY CONSENT FORM

ON-LINE SURVEY WITH CONSENT FORM
Emotions and Cardiovascular Activity

Dear Participants:

I am a graduate student under the direction of Professor Kory Floyd the Hugh Downs School of Human Communication at Arizona State University.

We are conducting a research study to examine the effects of various emotions on one's cardiovascular activity. We are inviting your participation to fill out a short online survey, which will take approximately 5 minutes to complete.

Your participation in this study is voluntary. You can skip questions if you wish. If you choose not to participate or to withdraw from the study at any time, there will be no penalty, and it will not affect your grade. The only requirement is that you must be 18 or older to participate in the study.

There are no foreseeable risks or discomforts to your participation in this survey.

Your responses will be confidential. After the survey, we will contact those participants that will make a good fit for our in-lab session. You will only receive extra credit points if you are selected for the in-lab session of this project. This lab session will involve being randomly assigned to various activities, which might elevate your heart rate and blood pressure. In addition, you may be asked to engage in various communication activities. Further, you may also be asked to watch a short video clip. Ultimately, you should know that during the 15-minute lab session, you will be attached to a non-invasive equipment which will measure your heart rate and blood pressure. The results of this study may be used in reports, presentations, or publications but your name will not be known.

If you have any questions concerning the research study, please contact the research team at: kory@asu.edu, ddeiss@asu.edu, (480) 331-3684. If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at (480) 965-6788.

If you give consent to participate, please click CONTINUE.

Sincerely,

Douglas Deiss, M.A.
Dr. Kory Floyd

ASU IRB
Approved
Sign Sf for Carol Johnston
Date 3/2/12 - 3/1/13

APPENDIX C

LABORATORY PROCEDURES CONSENT FORM

CONSENT FORM
AN EXPERIMENTAL REPLICATION AND REFINEMENT OF THE UNDOING HYPOTHESIS OF POSITIVE EMOTIONS

INTRODUCTION
The purposes of this form are to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

RESEARCHERS
Dr. Kory Floyd, Professor in the Hugh Downs School of Human Communication, and Douglas Deiss Jr., M.A. have invited your participation in a research study.

STUDY PURPOSE
The purpose of this research is to examine the effects of emotions on our bodies' cardiovascular activity.

DESCRIPTION OF RESEARCH STUDY
If you decide to participate, then as a study participant you will join a study involving research of emotions. In this study, you will be randomly assigned to various activities, which might elevate your heart rate and blood pressure. In addition, you may be asked to engage in various communication activities. Further, you may also be asked to watch a short video clip. Ultimately, you should know that during the 15-minute lab session, you will be attached to a sphygmomanometer which will measure your heart rate and blood pressure. This is a non-invasive method for assessing cardiovascular activity.

If you say YES, then your participation will last for 15 minutes at the Communication Sciences Laboratory at Stauffer A308. Approximately 88 subjects will be participating in this study.

RISKS
And as with any research, there is some possibility that you may be subject to risks that have not yet been identified. If selected for a minor exercise task, participants are at a slight chance of injury. This can be eliminated if you pay attention as you step up and down on the stool. If selected for a public speaking task, you may experience a small amount of anxiety based around the concept of presenting a speech. This task however, lasts only a short period of time. If you experience any negative psychological effects from the study, you can go to

Location

Psychological Counseling Center
Student Services Building, Room 334 Phone: 480.965.6146

Hours of operation

Office hours are: 8:00 am - 5:00 pm, Monday - Friday.

Emergencies After Office Hours:

Emergency services are available by calling the EMPACT Crisis Hotline 480.921.1006.

How to Make an Appointment:

Students may schedule an initial appointment by either visiting or calling ASU Counseling Services (CS) at 480.965.6146. ASU CS prioritizes immediate access to services to ensure that all students who request or need services can be seen within the same day. At the first appointment, an ASU CS counselor will meet briefly with the student to determine the type of services that would best serve the student's needs. This may include services at ASU CS, connection to additional resources at ASU, and/or referral to community resources.

BENEFITS
There are no benefits for you as a participant. However, there are possible benefits to society in general based on your participation in the research. That is, as a result of your participation, we may learn how to use emotions to help people in stressful situations.

ASU IRB
Approved
Sign SE for Carol Johnston
Date 3/2/12 - 3/1/13

NEW INFORMATION
If the researchers find new information during the study that would reasonably change your decision about participating, then they will provide this information to you.

CONFIDENTIALITY
All information obtained in this study is strictly confidential unless disclosure is required by law.The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records, Douglas Deiss will keep any record of personal information from the initial screening survey saved to a private and password protected drive on ASU's secure server (ASU MyFiles). Further, any paper documents from the lab session itself will be locked in a file drawer in Stauffer A308.

WITHDRAWAL PRIVILEGE
It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time. As students, you should know that your participation truly is voluntary and that nonparticipation or withdrawal from the study will not affect your grade.

COSTS AND PAYMENTS
The researchers want your decision about participating in the study to be absolutely voluntary. The only payment will be given by your instructor who will offer you extra credit for your participation in the study.

COMPENSATION FOR ILLNESS AND INJURY
If you agree to participate in the study, then your consent does not waive any of your legal rights. However, no funds have been set aside to compensate you in the event of injury.

VOLUNTARY CONSENT
Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Douglas Deiss, ddeiss@asu.edu, 480-455-8814.

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965 6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given (offered) to you.

Your signature below indicates that you consent to participate in the above study.

_______________________ _______________________ __________
Subject's Signature Printed Name Date

INVESTIGATOR'S STATEMENT
"I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided (offered) the subject/participant a copy of this signed consent document."

Signature of Investigator______________________________ Date__________

ASU IRB
Approved
Sign SJ for Carol Johnston
Date 3/2/12-3/1/13

APPENDIX D

SUBJECTIVE EMOTIONAL REPORT FORM

SUBJECTIVE EMOTIONAL REPORT FORM

Participant ID ______________

Please read each of the feelings listed below. For each, please **circle the number** representing how much of that feeling you are experiencing right now. An answer of 0 means you are not experiencing the feeling at all, and an answer of 8 means you are experiencing the feeling very strongly. The strength of a feeling should be viewed as a combination of (a) the number of times you felt the emotion; (b) the length of time you felt the emotion; and (c) how intense or extreme the emotion was. "Pained" refers to the experience of empathetic pain. "Aroused" is an index of your total emotional state.

	Not at All								*Very Much*
Interested	0	1	2	3	4	5	6	7	8
Angry	0	1	2	3	4	5	6	7	8
Disgusted	0	1	2	3	4	5	6	7	8
Fearful	0	1	2	3	4	5	6	7	8
Happy	0	1	2	3	4	5	6	7	8
Pained	0	1	2	3	4	5	6	7	8
Sad	0	1	2	3	4	5	6	7	8
Surprised	0	1	2	3	4	5	6	7	8
Aroused	0	1	2	3	4	5	6	7	8