Protective Effects of Positive Emotions

by

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Abstract

This dissertation investigates the protective effects of positive emotions in cognitive and physiological realms. Previous research indicates that positive emotions lead to broader thinking compared to negative emotions and have the ability to undo lingering physiological effects due to having experienced negative emotions. Drawing on this research, the dissertation aimed to determine if positive emotions also have protective capabilities against effects that negative emotions elicit such as narrowed thinking and heightened physiological arousal. Another purpose of the dissertation was to look at whether positive emotions experienced just before negative emotions speed physiological recovery back to baseline levels of physiological functioning. To examine whether positive emotional experiences protect against narrowed thinking due to experiencing negative emotions, I used a global-local visual processing task and measured the speed and accuracy of responding to either a global or local decision. To examine the physiological component, I employed physiological measurements of heart rate, respiratory sinus arrhythmia, skin conductance level, and skin conductance response. Contrary to expectations, positive emotions did not affect the speed or accuracy of responding to global or local decisions. Similarly, positive emotions experienced before negative emotions failed to protect against heightened physiological arousal and did not aid in physiological recovery. These findings failed to support the notion that positive emotions have protective effects, at least in regard to a short term manifestation of these effects.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

HR	Heart Rate
RSA	Respiratory Sinus Arrhythmia
SAM	Self-Assessment Manikin
SCL	Skin Conductance Level
SCR	Skin Conductance Response

Chapter 1

What is Positive Psychology?

Definition and Origin of Positive Psychology

Historically, social events that have influenced American psychology and dictated main research topics and perspectives were related to negative aspects of life to be contended with or avoided. For example, the eugenics movement influence (Galton, 1865; 1869; 1883; 1904), the large immigration from south and central Europe at the beginning of the twentieth century (Farberman, 2006; Kao, 1999; Rogler, 1994), and the entering of the US into the First World War provided the incentive for the mental measurement movement that focused on the detection of mental illness or “feebleness” more so than the improvement of mental abilities (Al-Issa & Tousignant, 1997). Likewise, the lack of psychiatrists to deal with psychosocial problems due to combat exposure during and after World War II incentivized the emergence in psychology of a medical model of mental illness that emphasized more the treatment of the illness than the prevention or fostering of mental health (Duckworth, Steen, & Seligman, 2005; Seligman, Parks, & Steen, 2004). Thus, it could be argued that psychology has focused more on the negative aspects affecting human behavior than on the positive ones.

The field of positive psychology has attempted to change the reactive aspects of psychology, such as the diagnosis of deficiencies and remedial treatment, to a more proactive approach fostering strengths and virtues. The term “positive psychology” was coined by Martin E.P. Seligman and Mihaly Csikszentmihalyi (2000) with the goal of creating a field focused on human well-being and the conditions, strengths, and virtues that allow people to thrive. The mission of positive psychology is to understand and foster the factors that allow individuals, communities, and societies to flourish (Seligman & Csikszentmihalyi, 2000). As such, positive psychology is an umbrella term for the study of the behavioral antecedents and consequences of positive emotions and positive character traits, and how this knowledge enables institutions to contribute to the flourishing and optimal functioning of individuals and groups (Gable & Haidt, 2005; Seligman, Steen, Park, & Peterson, 2005). A key aim of positive psychology is to change the focus of psychology to include the building of positive qualities, or things that make life most worth living (Seligman, Steen, Park, & Peterson, 2005), in addition to fixing the worst things in life (Seligman & Csikszentmihalyi, 2000). A shift to positive psychology has resulted in almost 1,000 articles being published in peer-reviewed journals between 2000 and 2010 on such topics as well-being, pride, forgiveness, happiness, mindfulness, and psychological strength. More recently, from 2010 to 2015, Google scholar yields over 5,000 articles related to positive psychology, thus, illustrating the impact that areas of positive psychology can have on both mental and physical health (Azar, 2011).

In terms of an evolutionary perspective, positive psychology states that psychological selection – the process whereby organisms better able to adapt psychologically to their environment are more likely to survive – is not motivated solely by the pressures of adaptation and survival, but also by the need to produce optimal experiences (Massimini & Delle Fave, 2000). This reemphasis on the positive side of psychology neither discredits the great strides that psychology has made remedying illnesses nor minimizes the distressing effects of negative aspects of life. Instead, it focuses on how current psychological science and positive psychology intertwine and strengthen the discipline as a whole and incorporates the full spectrum of human experience (Gable & Haidt, 2005). In particular, this full spectrum of human experience extends to research on the physiological underpinnings of emotional experiences. Thus, positive psychology aims to explore not just how negative emotions affect the body but also how positive emotions affect physiological responding.

With this in mind, this dissertation aimed to assess the effect of positive antecedents on individuals' behavior within the realm of physiological and cognitive reactions to emotion induction. Specifically, the dissertation focuses on determining if positive emotions protect people against heightened physiological responses and prevent narrowed cognitive responses. To set the stage for this task, an introduction to the field of positive psychology, models of positive emotions, and physiological and cognitive reactions in response to emotional stimuli are discussed.

A Natural Imbalance

Using a metaphor, Gable and Haidt summarized the perceived imbalance in current psychology: "psychology was said to be good at learning how to bring people up from negative eight to zero but not as good at understanding how people rise from zero to positive eight" (Gable & Haidt, 2005, p. 103). How did this imbalance of the field originate? First, problems inherently demand urgent attention. Historically, a focus on psychopathology was necessary in response to the increased amount of distressed veterans following World War II (Seligman, Parks, & Steen, 2004). In an effort to attend to the pressing issues regarding post-war mental illness, the more positive aspects of psychology took a backseat, and rightfully so, given the array of loss and suffering that stems from negative emotions (Fredrickson, 1998). Anger, for example, has been linked with larger and longer-lasting blood pressure responses that contribute to heart disease (Fredrickson et al., 2000); anxiety disorders and phobias have roots in negative emotions such as fear and anxiety (Beck, Emery, & Greenberg, 2005); unattended sadness may develop into full blown clinical depression, and depressed patients show increased death rates from cardiovascular disease (Glassman & Shapiro, 1998).

In contrast to negative emotions, positive emotions do not have the same dramatic implications with respect to psychological disorders. In fact, positive emotions relate to a reduced sympathetic activation of the cardiovascular system (Gross & Levenson, 1997) and therefore are disconnected from cardiovascular-related diseases. Positive personality traits, such as courage, future-mindedness, optimism, interpersonal skill, faith, work ethic, hope, honesty, and perseverance act as buffers against mental illness (Seligman, 2002). If such personality traits act as potential buffers against mental illness, then one could make the case that the study of such traits and their associated processes may indeed provide some important solutions to the problems that negative emotions generate (Slade, 2010).

A second argument for the imbalance between positive and regular psychology is that, from an evolutionarily perspective, it is adaptive to focus on potential threats rather than on potential rewards as the former may have dire consequences related to survival. As Fredrickson (2003) posited, studying variables that afflict the well-being of humanity naturally takes precedence because it is desirable to be rid of affliction. Fredrickson, Gable and Haidt (2005) suggested that those who are suffering should be helped before those who are doing well. Thus, in such cases, addressing ailments takes priority over pursuing strengths and virtues.

Despite the natural precedence of addressing suffering first, it is also important to consider those human strengths that prevent or ameliorate disease and disorder. Coping research, for example, demonstrates that appraising a negative life event in terms of the personal capability of meeting the challenge or overcoming the obstacle mediates the level of distress (Folkman & Lazarus, 1988). Similarly, optimism, a sense of personal control, and meaning in life have been shown to be protective factors for psychological and physical health (Taylor, 1983; Taylor et al., 2000). Positive emotions also increase life satisfaction in countries where positive emotions are socially valued (Bastian, Kuppens, De Roover, & Diener, 2014) and build resilience (Cohn, Fredrickson, Brown, Mikels, & Conway, 2011; Mak, Ng, & Wong, 2011). Capitalizing on research from human strengths provides a basis for investigating the buffering properties of positive emotions, which is one of the aims of the current dissertation. Given that resiliency and prevention are beginning to take the spotlight in modern medicine, positive psychology research may yield important insights into the mechanisms underlying the documented potent health benefits.

A third reason why psychology has focused on negative events has to do with their stronger influence over good events when processing information about life events, close relationships, social network patterns, interpersonal interactions, and the learning process (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001, for a review; Pratto & John, 1991; Taylor, 1991; Wentura, Rothermund, & Bak, 2000). In Baumeister et al.'s review of literature, information about bad events was processed more thoroughly than information about good events. Notwithstanding the more thorough processing of bad events, it is possible to cultivate a more balanced assessment of positive and negative emotional experiences that increase subjective well-being (Diener, Sandvik, & Pavot, 2009). Therein lies a need of studying factors that increase subjective well-being and how those factors prevent and undo effects of negative emotional experiences.

Fourth, Fredrickson (2003) contended that the smaller body of research for positive aspects of life, such as the study of positive emotions, is, in part, due to the fact that positive emotions are more difficult to study. For example, anger, fear, and sadness, are recognized as distinctly different emotional experiences; however, joy, gladness, and elation are not easily distinguished from one another and they have structures that are hard to define (De Rivera, Possell, Verette, & Weiner, 1989). In essence, positive emotions are less differentiable than negative ones (Ellsworth & Smith, 1988). This lack of differentiation is evident in scientific taxonomies of basic emotions that identify one positive emotion for every three or four negative emotions (Ekman, 1992a; 1992b; Izard, 1978). An imbalance of positive versus negative emotions is also shown in research on facial expression of emotion. For example, Ekman (1984) distinguished five to eight negative states based on specific facial configurations with unique and universally recognized signal value. Positive states, on the other hand, were not shown to have a unique signal value outside the Duchenne smile of raised lip corners accompanied by muscle contraction around the eyes (Ekman, 1992a). This lack of differentiation extends to autonomic nervous system responses. Anger, fear, and sadness each elicit distinct responses in the autonomic nervous system. In contrast, positive emotions appeared to have no or little distinguishable autonomic responses (Levenson, 1992; Levenson, Ekman, & Freisen, 1990). Having or not having distinguishable autonomic responses may also highlight the differences in the biological relevance of positive and negative emotions—with negative emotions usually signaling important features in our environment for which it is necessary to prepare the body, whereas positive emotions may work more in the background. Thus, the effects associated with positive emotions may not be immediately observable because they are less noticeable and may not act as signals in the same manner as negative emotions. As previously stated negative, emotions are attention grabbing, occur on a truncated time scale, and have more robust effects compared to positive emotions. Thus, it is possible that the effects of positive emotions are not as salient and build over time, making them difficult to assess and examine.

Theories of Positive Emotions

The difficulties in studying positive emotions have been a hindrance for research in the affective sciences, particularly with regard to positive psychology. The focus on negative/threatening aspects of life may have inadvertently clouded the distinctive role of positive emotions as compared to negative emotions. In fact, most theories of emotion have combined positive and negative emotions and assumed them to have similar properties due to the relative lack of research on positive emotions (Fredrickson, 1998). Nonetheless, it has been established that positive and negative emotions are processed differently in the brain (Kirby & Robinson, 2015), and thus are likely to have different autonomic and behavioral consequences.

A central tenant of many theories of emotion is that emotions are associated with motivation to act in particular ways (Fridja, Kuipers, & Schure, 1989); in other words, discrete emotions function to elicit specific action tendencies (Levenson, 1994; Smith & Lazarus, 1990; Tooby & Cosmides, 1990). For instance, according to Fridja et al., (1989) anger creates the urge to attack, fear the urge to escape, and disgust the urge to expectorate. Along with these urges come specific physiological changes that enable the particular actions to be carried out should the decision to act out those urges arise. For example, a greater amount of blood flows to the larger muscle groups to facilitate running or fighting in the case of fear (Levenson, 1992; 1994). These specific urges and action tendencies narrow thought-action repertoires to those that best promoted our ancestors' survival in life-threatening situations (Fredrickson, 1998; 2001; Tooby & Cosmides, 1990) suggesting that cognitive and physiological reactions to negative emotions are evolved adaptations.

What of positive emotions? What adaptive value can be attached to cognitive and physiological reactions associated with positive emotions? Fredrickson (1998) argued that many positive emotions do not fit models that attribute specific action tendencies to the experience of the emotion because positive emotions are often not directly related to life-threatening situations. However, they may have an indirect relation. For example, in life-threatening situations, those with greater reserves of personal resources (i.e. physical skills, health, friendships, social support networks, knowledge, resilience, optimism, and creativity), obtained from previous experiences with positive emotions, may have higher odds of survival (Fredrickson, 1998). Accordingly, positive emotions are more related to growth and development of strengths and virtues than with survival mechanisms in dire situations (Fredrickson, 2003), although they may have the potential to indirectly increase survival. Thus, positive emotions do not necessitate specific courses of action but instead build reserves of durable positive resources that may be drawn upon to solve future problems (Fredrickson, 2001; 2003).

Although little is known regarding the specific actions and urges elicited by positive emotions, more general ideas of actions and urges related to positive emotions can be seen. For example, De Rivera et al. (1989) showed that positive emotions, such as elation and joy, manifest themselves in the person's propensity to jump, run, shout, announce good news, and more. Likewise, Frijda (1989) coined the term *free activation*, essentially meaning the readiness to be involved in whatever is to come, as an action tendency associated with joy, interest with that action of attending, and contentment with an activity. These actions are broader in nature than those of negative emotions yet could still be reasoned as urges to action although in less specific ways. The vagueness in action tendencies for positive emotions is a primary basis for Fredrickson's and Levenson's (1998) perspective that a general-purpose model of all emotions is inadequate at describing the purposes and functions of positive emotions.

Fredrickson (1998) proposed that a more suitable model for positive emotions should not include the assumption that specific action tendencies must accompany an emotion. Nor should theories of positive emotions assume action tendencies to be purely physical; instead, cognitive tendencies should also be considered. As a result, instead of action tendencies, she suggested the idea of *thought-action tendencies.* Thought-action tendencies refer to the thoughts and actions that come to mind in situations that necessitate some sort of decision or in situations evoking emotion. An important distinction from models of specific action tendencies is that these thought-action tendencies need not necessarily be specific. For example, narrowed thought-action tendencies accompany negative emotions, but less specific actions associated with positive emotions, such as a pursuance of novel, creative, and off-the-cuff thoughts and actions, embody broadened thought-action tendencies (Fredrickson, 1998). Joy, for instance, creates urges to play, which appears to be a generic term for a number of different actions in physical, social, intellectual, and artistic realms. Consequently, the thought-action repertoire is broadened to include an array of nonspecific actions when joy is experienced (Fredrickson, 1998). Building on the idea that positive emotions broaden thought-action repertoires, Fredrickson (2001) created the Broaden-and-Build Theory of Positive Emotions. The broaden-and-build theory of positive emotions serves as the primary theoretical basis for the current study.

The Broaden-and-Build Theory of Positive Emotions

The broaden-and-build theory states that:

> certain discrete, positive emotions—including joy, interest, contentment, pride, and love—although phenomenologically distinct, all share the ability to broaden people's momentary thought-action repertoires and build their enduring personal resources, ranging from physical and intellectual resources to social and psychological resources. (Fredrickson, 1998, p. 219)

To illustrate the enduring effects of positive emotions, Fredrickson (2003) surveyed people to examine their resilience and optimism. People were interviewed in the early months of 2001, and then again after the September 11th terrorist attacks. Those individuals identified as resilient and optimistic individuals prior to the terrorist attacks were half as likely to be depressed as less optimistic or nonresilient individuals; resilience and optimism appeared to act as buffers against depression. In another study, participants induced to feel either negative or positive emotions listed thoughts and actions that came to mind when feeling those emotions (Fredrickson & Branigan, 2005). Those participants induced to feel positive emotions listed more thoughts and action urges compared with people experiencing negative emotional states, in essence exhibiting a complementary effect to discrete emotion theories involving specific action tendencies (Fredrickson 1998; Fredrickson & Branigan, 2005).

Broadening effects of positive emotions. One central premise of the broaden-and-build theory is the *broaden hypothesis*, which states that "positive emotions broaden the scope of the attention, cognition, and action, widening the array of percepts, thoughts, and actions presently in mind. A corollary *narrow hypothesis* states that negative emotions shrink the same arrays" (Fredrickson & Branigan, 2005, p. 315). Several studies support the broaden hypothesis in areas such as problem solving (Isen, Daubman, & Nowicki, 1987; Isen, Rosenzweig, & Young, 1991), reasoning (Estrada, Isen, & Young, 1997), word association (Isen, Johnson, Mertz, & Robinson, 1985), categorization (Isen & Daubman, 1984), decision-making, and attention (Fredrickson & Branigan, 2005). For example, in a study on reasoning, Estrada et al. (1997) showed that physicians in whom positive affect was induced via reception of a small package of candy were more efficient at integrating diagnostic information for a liver disease diagnosis than physicians in a control group or physicians that only read about a humanistic approach to medical practice. In addition, those physicians were less likely to become anchored to their initial diagnosis, meaning they were more flexible in their thinking and willing to explore other possible diagnoses despite already having an initial diagnosis in mind.

When investigating the broadening aspect of specific positive emotions, researchers have shown that “joy” broadens thought-action repertoires by fostering creativity and playfulness (Frijda, Kuipers, & Schure, 1989). “Interest” fosters exploration and understanding of experiences and events (Ellsworth & Smith, 1988) that are not specific actions themselves. “Contentment” broadens by eliciting the urge to savor the present and foster new self and world views (Fredrickson, 1998). “Love” encourages actions and thoughts that instigate intrinsic enjoyment (Fredrickson, 1998). These urges or actions stemming from the experience of positive emotions are not specific in nature.

Though anecdotal broadening effects of positive emotions are supported in the literature, Fredrickson and Branigan (2005) empirically tested whether positive emotions broaden the scope of attention and thought-action repertoires. They used a global-local visual processing task, a common task for investigating wholistic versus configural processing (e.g. Andres & Fernandes, 2006; Gasper & Clore, 2002; Kimchi, 1992; Pletzer, Petasis, & Cahill, 2014; Tan, Jones, & Watson, 2009) and a modified Twenty Statements Test (Kuhn & McPartland, 1954) after inducing affective states of amusement, contentment, neutrality, anger, or anxiety via film viewing. In both tasks, the global-local visual processing choice task (Experiment 1) and the

Twenty Statements Test (Experiment 2), positive emotions broadened the scope of attention and thought-action repertoires. For the global-local visual processing choice task, participants viewed a stimulus triad that consisted of a standard figure on top and two comparison figures below it (see Figure 1). Participants selected which of the two comparison figures was most similar to the standard figure. Their judgments could have been based on either the global configuration aspect or the local elements making up the standard figure. Broader thinking was illustrated if participants selected the item that represented the "big picture" or global shape of the group of geometric figures rather than focusing on the individual figures themselves and selecting the figure matching the individual shapes. Participants induced to feel positive emotions tended to choose the global configuration more frequently than those in negative or neutral states. Similar results have been shown using Navon's (1977) global-local task involving stimuli that consist of letters of the alphabet. With respect to the modified Twenty Statements Test (20 blank lines that begin with the phrase "I would like to ___________" for the participant to fill in), participants in the two positive emotion conditions, joy and contentment, recorded more responses than either of the two negative emotion conditions and the neutral condition indicative of broader thinking in the positive emotion groups. Likewise, the two negative emotion conditions had fewer responses relative to the neutral condition, the latter lending support to the notion that negative emotions 'narrow' cognitive processes.

The Undoing Hypothesis

Thus far it has been noted that negative emotions have specific physiological responses associated with them in addition to narrowing people's mindsets (Fridja, Kuipers, & Schure, 1989; Smith & Lazarus, 1990). Positive emotions on the other hand, are associated with a relative lack of physiological response (Levenson, Ekman, & Friesen, 1990) and broaden people's mindsets (Fredrickson, 1998; Fredrickson & Branigan, 2005). Thus, it is plausible that positive emotions undo the lingering effects of negative emotions, not only cognitively, but physiologically as well. This proposition is formally known as the *undoing hypothesis* (Fredrickson et al., 2000).

Physiological Responses Associated with Negative Emotions

Physiological responses related to negative emotions include variations in heart rate (HR) acceleration (Levenson, 1992), changes in diastolic blood pressure and vasoconstriction (Levenson, 1992), changes in skin conductance level (SCL: Fernandez et al., 2012), fluctuations in finger temperature (Levenson, Ekman, & Friesen, 1990), and differences in facial electromyography activity (EMG: Bradley, 2000). In several experiments, Levenson, Ekman, and Friesen (1990) revealed several reliable autonomic nervous system (ANS) responses to negative emotions using a relived emotions task and directed facial action task. In the relived emotions task, subjects were to recall and relive emotional memories for each of six different basic emotions (anger, disgust, fear, happiness, sadness, and surprise). For the directed facial action task, a coach instructed subjects to contract certain facial muscles to produce facial configurations that are morphologically identical to prototypical emotional expressions (see Ekman & Friesen, 1978 for the Facial Action Coding System: FACS). Levenson et al. (1990) discovered that anger, fear, and sadness produced larger heart rate acceleration than disgust. In addition, anger produced larger finger temperature increase than fear. Although fear and anger are both associated with accelerated HR, their physiological responses diverge with respect to diastolic blood pressure and finger temperature (Levenson, 1992). Taken together, these data support distinct patterns of autonomic activity of anger versus fear.

Levenson (1992) suggested the physiological responses associated with anger and fear can be linked to motor programs for specific action tendencies (Frijda, 1986). For example, anger has the specific action tendency of "fight" could make significant metabolic demands on the heart, leading to an accelerated heart rate. Similarly, fear's close association with the action tendency of "flight" may require additional cardiovascular effort, evidenced as accelerated HR, in order to accomplish the act of fleeing. The association of sadness with accelerated HR is perhaps harder to explain with an action tendency, although Levenson (1992) speculated that sadness is a stress response that accelerates HR in effort to motivate the individual to seek remedies for the sadness. Disgust, although also considered a negative emotion, appeared to be associated with HR deceleration. However, evidence regarding disgust and its attendant physiological response is scarce (Levenson, 1992).

Not only were physiological differences found among negative emotions, positive emotions compared to negative emotions also displayed divergent results. For instance, anger and fear produced larger heart rate acceleration and larger SCL increases than happiness. These findings among negative emotions and positive emotions have been supported cross-culturally (Levenson, 1992; Levenson, Ekman, Heider, & Friesen, 1991) and in the elderly (Levenson, 1992). Fernandez et al. (2012) found similar results in their investigation of whether a set of film clips with discrete emotions (anger, fear, sadness, disgust, amusement, tenderness, and neutral) were capable of eliciting physiological responses. Indeed, viewing fear films significantly increased SCL and HR as compared to neutral films. Likewise, viewing anger films resulted in significant increases in HR as compared to neutral films. “Sadness” did not provoke significant increases in HR, although a trend toward significance was present. Regarding the comparison of negative emotions versus positive emotions, the two groups of emotions did not differ significantly which is inconsistent with the work of Levenson et al. (1990).

More obvious overt physiological expressions occur in facial electromyography activity, specifically in the corrugator supercilii muscles and the zygomatic muscle (Bradley, 2000). The corrugator muscles lower and contract the brows, such as in the facial expression of distress (Ekman & Freissen, 1986). Activity in the corrugator muscles occurs when viewing unpleasant pictures; however, the corrugator muscles are relaxed when viewing pleasant images (Bradley, 2000). Thus, activity in the corrugator muscles are a function of the valence of the image (i.e., increased activity for unpleasant images and decreased activity for pleasant images). The zygomatic major muscle is activated when the cheek is drawn back or tightened, as in smiling. Consequently, the activity of the zygomatic muscle increases when viewing pleasant pictures. Interestingly, the zygomatic muscle is also activated when viewing highly unpleasant images along with activity of the corrugator muscles indicating a combination of the two muscle regions when perceiving highly aversive materials.

Evidence for the Undoing Hypothesis

Physiologically, the undoing hypothesis suggests that positive emotions serve to restore autonomic activity to more midrange levels (Fredrickson & Levenson, 1998). To test this notion, Fredrickson and Levenson (1998) induced cardiovascular reactivity (raise in blood pressure and heart rate) by showing research participants a film that elicited fear. Immediately following this clip, participants, after random assignment, watched a second clip to elicit either (a) contentment, (b) amusement, (c) neutrality, or (d) sadness. Those who viewed either of the two positive emotion clips showed the fastest cardiovascular recovery to baseline, lending support to the undoing hypothesis. The time elapsed until each participant returned to pre-film resting baseline levels quantified cardiovascular recovery of the participants.

In a similar vein, Fredrickson et al. (2000), told participants that they had 1 minute to prepare a speech on the topic “why you are a good friend” that would be videotaped and evaluated by their peers. This manipulation induced a feeling of anxiety, increased participants’ heart rate, peripheral vasoconstriction, and blood pressure. After 60 seconds of the anxiety-provoking situation, participants watched a second clip to elicit either (a) contentment, (b) joy, (c) neutrality, or (d) sadness. The results were again consistent with the undoing hypothesis. Specifically, those individuals who watched the two positive-emotion films recovered to their baseline cardiovascular activity sooner than those who watched either the neutral or sad films.

Notably, the two positive-emotion films produced indistinguishable cardiovascular changes compared with that of the neutral film giving evidence that the differing effects on cardiovascular recovery could not be due to a difference in arousal between the positive and neutral clips.

Putting the Undoing Effect into Practice

Based on supportive evidence for the undoing hypothesis, positive emotions may have the power to undo the lingering physiological effects of negative emotions. Positive emotions serve to bring the body back to mid-range levels of cardiovascular activity. Thus, cultivating positive emotions would be an effective coping mechanism in dealing with the effects of negative emotions. Fredrickson (2001) postulated that another aspect of the broaden-and-build theory of positive emotions involves that ability of positive emotions to fuel physiological and psychological resilience.

Resilient individuals will bounce back from stressful events or experiences quickly and efficiently (Block & Kremen, 1996). Indeed, participants labeled as more resilient based on Block and Kremen's (1996) Ego-Resiliency Scale exhibited significantly faster returns to baseline levels of cardiovascular reactivity in Fredrickson's and colleagues' (2000) speech task. In addition, resilient individuals reported higher levels of positive emotions before the speech task and after the speech task consistent with the notion that positive emotions fuel psychological resilience. Mediational analyses also showed that positive emotions mediate the effect of individual resilience on cardiovascular recovery and cognitive reappraisal of negative circumstances (Tugade & Fredrickson, 2004). The relation between positive emotions and resilience is one of mutual enhancement resulting in upward spirals of emotional well-being (Fredrickson & Joiner, 2002).

Protective Effects of Positive Emotions

Theories of positive emotions highlight the roles of positive emotions in broadening and building people's thought-action repertoires, physical and intellectual resources, and social and psychological resources (Fredrickson, 1998; 2001). Additionally, there is evidence that positive emotions hasten recovery from lingering effects of negative emotions (Fredrickson et al., 2000) and play a role in psychological resilience (Fredrickson 2001; Tugade & Fredrickson, 2004). Capitalizing on these ideas and evidence, I aimed to investigate the idea that positive emotions may also have a protective role on cognitive and physiological responses when experienced immediately before negative emotions. In other words, if positive emotions have broadening and building capabilities, positive emotions will also prevent or protect against subsequent narrowing effects from negative emotions. Likewise, if positive emotions act as antidotes to lingering physiological effects of negative emotions, positive emotions will also protect against the heightened cardiovascular activity triggered by negative emotions.

In order to address these hypotheses, I attempted to induce participants' to feel positive and negative emotions in a laboratory setting using emotion-eliciting films from a library developed for affective scientists (Samson, Kreibig, Soderstrom, Wade, & Gross, 2015). Emotion-eliciting films are one of the most commonly used techniques to induce emotions

(Fernandez et al., 2012; Knautz & Stock, 2010) and appear to be effective at eliciting their physiological signatures (see Kreibig, 2010, for a review). I incorporated an array of physiological measures such as heart rate, respiratory sinus arrhythmia, skin conductance level, and skin conductance responses. The physiological measures continually measured biological changes in the participants throughout the experiment in an effort to determine whether positive emotions experienced prior to negative emotions protect against heightened physiological arousal due to the experience of negative emotions. Similar to Fredrickson and Branigan (2005), I used a global-local visual processing task (Navon, 1977) and a modified version of the Twenty Statements Test (Kuhn & McPartland, 1954) for the purpose of assessing whether positive emotions' ability to broaden individuals' thinking remains after the exposure to negative emotions.

Hypotheses

First, I hypothesized that participants induced to feel positive emotions prior to the induction of negative affect would retain a broader thinking approach (i.e. exhibit greater accuracy and speed on global decisions on the global-local processing task and more responses on the Twenty Statement Test), than participants induced to feel neutral or negative emotions prior to negative emotion induction. Second, I hypothesized that individuals viewing positive emotion eliciting film clips immediately before viewing negative emotion ones would exhibit lower physiological arousal to the negative clips than individuals who viewed either neutral or negative emotion clips before watching the negative ones. This hypothesis illustrates the proposed physiological protective effects of positive emotions compared to neutral and negative emotions. Third, I hypothesized that individuals viewing the positive emotion clips first would return faster to their physiological baseline after watching the negative emotions clips than those individuals in either the neutral or negative film viewing groups. This hypothesis is in line with the notion that positive emotions fuel psychological resilience and associatively, physiological resilience. Last, I hypothesized that resilience and optimism would be correlated with participants' physiological levels during baseline and during the viewing of the second negative set of film clips. A more detailed methodological account follows (see also Appendix D for a graphical representation of the experimental design).

Chapter 2

Methods

Participants

Eighty-two students (70 undergraduates and 12 graduate students) enrolled in courses at Auburn University participated in this study. The undergraduate participants received extra-credit for their participation. The graduate students did not receive any compensation. All participants completed prescreening questionnaires for psychological distress in order to protect against any unnecessary harm due to watching emotion related film clips. The mean age of the participants was 20 (Range: 18-33; SD = 3.13). Participants had an average GPA of 3.30 (Range: 2.0-4.0; SD = 0.45).   Psychology majors made up 28.6% (N = 24) of the participants with the remaining participants spanning a wide range of other disciplines. Among the undergraduate students, 42.9% (*N* = 36) were freshmen, 21.4% (*N* = 18) sophomores, 11.9% (*N* = 10) juniors, and 7.1% (*N* = 6) seniors. Females accounted for 70.2% (N = 59) of the sample. Caucasians made up 84.7% (N = 72) of the participants, African Americans 8.2% (N = 7), Asians 8.2% (N = 7), Hispanics 3.5% (N = 3), and other category 3.5% (N = 3). Participants were randomly assigned to one of three conditions, negative (N = 27), neutral (N = 27), and positive (N = 28), each condition representing the type of emotion eliciting films viewed prior to viewing negative emotion eliciting films.

Materials

Visual. Sixteen short film clips from the Film Library for Affective Scientists (Samson et al., 2015) served as emotion inducing stimuli in this study. Film clips ranged from 20 to 33 seconds in length and Samson et al. (2015) had a sample of 411 individuals use a 1 to 6 Likert scale to rate each film in the library according to its valence, arousal, amusement, love, pride, repulsion, fear, anger, sadness, and neutrality. These scores served to classify clips as generating positive, negative, mixed, or neutral emotions and are used to describe the specific film clips selected for use in the current paper.

The four film clips used to induce positive emotion were: (a) a clip showing a mother prompting a baby to put hands in the air at which point an entire crowd puts hands in the air and cheers after the baby does it, (b) a second clip showing a dog singing to a melody from an iPad, (c) a third clip showing a group of pandas laying around with one panda who cannot stop sneezing, (d) and a fourth clip showing a baby trying to hula hoop without the hula hoop, (i.e. the baby just wiggles hips around while everyone laughs). Each of these film clips has a high positive average valence (5.32, 4.94, 4.68, and 5.03, respectively) on a scale from 1 (very negative) to 6 (very positive; Samson et al., 2015). Their average arousal ratings are 2.75, 2.83, 2.75, and 2.77, respectively, on a scale ranging from 1 to 6 (1 = not at all arousing; 6 = very strongly arousing; Samson et al., 2015).

The four film clips used to induce neutral emotion were: (a) a clip depicting a brief lesson on beginning to knit, (b) a second clip showing a man planting seeds, (c) a third clip showing people walking through the streets at night, and (d) a fourth clip showing a man riding a horse. Average valence ratings for the neutral clips are 3.52, 3.45, 3.29, and 3.51 (Samson et al., 2015), respectively and their average arousal ratings are 1.52, 1.46, 1.69, and 1.5, respectively (Samson et al., 2015).

Eight film clips served to induce negative emotion. The negative group viewed four clips during the first film viewing portion of the experiment. All three groups viewed the other four clips during the second film viewing part of the experiment. The four clips used in the first film viewing portion of the experiment: (a) one clip showing a bull throwing and trampling a torero, (b) a second clip showing a boy trying to balance from one pole to the next pole, slips, and hits the pole with his hips, (c) a third clip showing a man demonstrating a daredevil trick in front of a crowd by sticking his arm in a crocodile's mouth, being bitten by it, and then run off with a bleeding arm, and (d) a fourth clip showing a boy who jumps down a flight of stairs on a skateboard and breaks his ankle; the clip also shows him in the hospital with the bone deformed. These four clips have average valance ratings of 2.03, 2.14, 1.77, and 1.69, respectively (Samson et al., 2015). The average arousal ratings for the four clips are 2.92, 2.58, 2.99, and 2.78, respectively (Samson et al., 2015).

All participants viewed the remaining four negative film clips during the second film clip viewing portion of the experiment: (a) a clip showing a skater who breaks his arm after a skateboard stunt on a rail (this particular clip has foul language for which the participants were warned prior to participating in the study), (b) a second clip showing a boy sitting in a car who decides to jump out only to be hit in mid jump by a car in the next lane of traffic, (c) a third clip showing a boy doing a back flip off a vending machine and hitting his face on the concrete, and (d) a fourth clip showing a boy riding a skateboard down stairs, falling hard on his hand, and sitting up cradling his now disfigured wrist. Average valence ratings for the second set of negative film clips are 1.68, 1.6, 2.21, and 1.82, respectively, and average arousal ratings are 3.23, 2.54, 2.7, and 2.3, respectively, (Samson et al., 2015). The positive and negative film clips selected, allowed for their valence to be statistically different and arousal to be statistically similar across conditions. Selected neutral film clips were statistically different concerning valence. The arousal levels of the neutral clips are statistically lower than either positive or negative film clips.

In addition to the film clips, participants completed a global-local processing task (Navon, 1977). In this task, participants looked at large letters of the alphabet composed of smaller letters (see Appendix A) displayed on a computer screen using the EPrime 2.0 software (Psychology Software Tools, Pittsburgh, PA). In each trial the participants first viewed a screen instructing them to report the large letter (indicative of a global response) or the smaller component letters (indicative of a local response) of the stimulus to be presented in the next screen. When the actual stimulus is presented, EPrime 2.0 software (Psychology Software Tools, Pittsburgh, PA) records the participants' accuracy and response. Participants completed 24 trials in total, 12 asking for a global response and 12 asking for a local response.

Written. In the prescreening phase, the measures included a demographic and medical history questionnaire, the Posttraumatic Disorder Checklist (PCL-5; Weathers et al., 2013), Beck Depression Inventory – II (BDI – II; Beck, Steer, Ball, & Ranieri, 1996), Beck Anxiety Inventory – II (BAI; Beck & Steer, 1993), Ego-Resilience Scale (Block & Kremen, 1996), and the 9-item version of the Personal Optimism and Self-Efficacy Optimism Scales (Gavrilov-Jerković, Jovanović, Žuljević, & Brdarić, 2014). The demographics questionnaire obtained background information such as gender, age, major, year in school, and GPA. The medical questionnaire asked participants about their history of illnesses including head trauma, stroke, epilepsy, neurological problems, and psychiatric illness and if they were currently taking medications. The PCL-5 serves as the PTSD checklist for the DSM-5 and served to assess the level of post-traumatic stress participants have endured. Both the BDI – II and the BAI served as measures of depression and anxiety, respectively.

In the second phase of the study, during the actual experiment, participants reported their subjective experiences using two self-report questionnaires. In one questionnaire, participants rated the intensity in which they felt the following emotions: amusement, anger, anxiety, disgust, fear, happiness, humor (amusement), and sadness. Participants responded using 9-point Likert scales (0 = *none*, 9 = *a great deal*). In a second self-report, participants indicated their perceived level of valence and arousal using the Self-Assessment Manikin (SAM; Bradley & Lang, 1994; see Appendix B for computer screen adapted version). The valence rating on the SAM consists of five figures ranging from a smiley, happy figure to a frowning, unhappy figure. Likewise, the arousal rating of the SAM includes five figures ranging from an excited, wide-eyed figure to a relaxed sleepy figure. Finally, a modified version of the Twenty Statements Test (Kuhn & McPartland, 1954, see Appendix C) assessed broadened thinking in Phase 2. The modified version of the Twenty Statements Test instructs participants to

> "take a moment to imagine being in a situation yourself in which this particular emotion would arise (the emotion you felt after viewing the videos). Concentrate on all the emotion you would feel and live it as vividly and as deeply as possible. *Given this feeling,* please *list* all the things you would like to do *right now.*"

Following the instructions were 20 blank lines for participant responses. Scoring of the Twenty Statements Test includes counting the number of responses completed.

Physiological. Three BIOPAC modules and Acqknowledge software (BIOPAC Systems, Inc., 2016) continuously recorded physiological functioning of electrodermal responses, electrocardiography, and respiration. These recordings output response variables including heart rate, respiratory sinus arrhythmia, skin conductance level (tonic EDA), and skin conductance response (number of EDA responses). The units of analysis were interval averages computed based on predesignated sections in the experimental design (i.e., first set of film viewing, SAM1 completion, the second set of film viewing, SAM2 completion, and the period after the second set of film viewing to the end of the experiment).

Electrodermal Response (EDR) (Biopac product #EDA100C-MRI): Two electrodes placed on the third and fourth finger of each participant measured electro-dermal response, i.e., electrical conductance of the skin measured in microSiemens (μS; reciprocal of Mega Ohms). A computer digitally recorded this measure. Larger values indicate increased sympathetic arousal.

Electrocardiograph (ECG) (Biopac product #ECG100C-MRI): Two electrodes were measured electrocardiography. Placement of the electrodes included one electrode on the right collarbone, and the other on the participants' left rib. Acqknowledge software (BIOPAC Systems, Inc., 2016) digitally recorded measures and computed the variability of the time intervals between consecutive heart beats, beats per minute. Increases in heart rate may reflect increased sympathetic activity, decreased parasympathetic activity, or some combination, and indicate an arousal-related response.

Respiration (Biopac product #RSP100C): A respiration belt wrapped around the participants' upper waist measured respiration. The primary utility of the respiration belt was for accuracy in calculating respiratory sinus arrhythmia. Changes in respiratory sinus arrhythmia are indicative of changes in parasympathetic activity.

Procedure

SONA web system and in-class advertisements were the primary means of participant recruitment (for a graphical representation of the procedure timeline see Appendix D).

Phase 1 – Prescreening. Participants completed three pre-screening questionnaires related to emotion identification, regulation, and psychological disorders. Only participants within a normal range of scores were included in Phase 2. For participants qualified as within normal range provided that they scored below a 28 on the Beck Depression Inventory – II (BDI-II; Beck et al., 1996) , below 29 on the Beck Anxiety Inventory (BAI; Beck & Steer, 1993), and below a 30 on the PTSD Checklist for DSM-5 (PCL-C; Weathers et al., 2014). During the prescreening phase, participants completed the Ego-Resilience Scale, and the 9-item Version of the Personal Optimism and Self-Efficacy Optimism Scales. Those participants qualifying to participate in Phase 2 received a recruitment e-mail. Participant email addresses linked Phase 1 and Phase 2 data.

Phase 2 – Video viewing and physiological data collection. Upon arrival to the lab, participants completed the informed consent. After consenting, participants completed the SAM for the first time as well as the 9-point Likert scale emotion questionnaire. Next research assistants attached physiological recording equipment to the participants, and equipment was checked to make sure it was providing proper physiological reading. Following electrode attachment, participants began the experimental task. EPrime 2.0 software (Psychology Software Tools, Pittsburgh, PA) randomly assigned participants to one of three conditions: a positive, negative, or neutral condition. Prior to any experimental manipulation all participants underwent a 5-minute baseline period in which continual recording of physiological levels occurred, as has been done in previous physiological research (Fernandez et al., 2012).

After the baseline period, and according to their experimental group, participants viewed the four videos intended to elicit positive, negative, or neutral emotions. In total, the first video viewing portion lasted about 2 minutes. Immediately following this first video presentation, participants completed, for the second time, the SAM. Then participants in all groups viewed the same four negative videos (about 2 minutes in total), intended to elicit negative emotions. Following this second video presentation participants completed for the third time the SAM. Afterwards, participants completed the global-local visual processing task and the modified version of the Twenty Statements Test. Finally, participants completed, for the fourth time, the SAM and for the second time, the 9-point Likert scale emotion questionnaire. For the 9-point Likert scale emotion questionnaire, participants completed the scale while attempting to remember the emotion felt during the first four videos and then completed the scale again while attempting to remember the emotion felt during the second four videos they watched. The experiment concluded with the removal of electrodes and debriefing.

Chapter 3

Results

Global-Local Task

Accuracy. Table 1 summarizes the average number of correct responses and standard deviations for each group according to scope type: global and local. A 3 X 2 repeated measures ANOVA assessed differences in accuracy for each scope type (global vs. local) among the three groups (positive, negative, and neutral). ANOVA results did not yield a significant effect of scope, $F(1, 79) = 3.563$, $p = .063$, nor a significant interaction of scope and group, $F(2, 79) = 1.112$, $p = .334$ (see Table 2 for corresponding ANOVA table). These results did not support the hypothesis that the positive group would respond more accurately on the global instruction trials than either the negative or neutral groups.

Response Times. Table 3 summarizes the means and standard deviations for response times on the Global-Local task by scope. A 3 X 2 repeated measures ANOVA assessed differences in response times for the three groups (positive, negative, and neutral) by scope (global vs. local). Results did not reveal a significant main effect for scope, $F(1, 79) = .685$, $p = .410$, nor a significant interaction of scope and group, $F(2, 79) = .174$, $p = .840$ (see Table 4 for corresponding ANOVA table). These results did not support the hypothesis that the positive group would respond more quickly on the global instruction trials than either the negative or neutral groups.

Twenty Statements Test

Table 5 displays the means and standard deviations for the number of responses on the Twenty-Statement Test. A One-Way ANOVA did not reveal a significant difference in the number of responses among the groups, $F(2, 79) = 2.724$, $p = .072$. In particular, it was expected that the positive group would exhibit more responses on the TST than the neutral group and negative groups but the expectation was not supported.

Physiology

Focus areas of the raw physiological data file for the last 2 minutes of the 5 minute baseline, the approximate 2 minutes of treatment presentation (first set of videos), the 20 seconds of SAM1 answering, the approximate 2 minutes of test (second set of videos), the 20 seconds of

SAM2 answering, and the approximate 7 minutes of cognitive tasks time periods, aided in analysis of the physiological data. Acqknowledge software (BIOPAC Systems, Inc., 2016) computed averages for each focus area and exported those averages into spreadsheets to be used for analysis. Subsequent analyses compared the treatment groups at the test period for each physiological measure and employed ANCOVA with participants' average physiological response during the two minute baseline period as covariate (see Table 6 for baseline averages on physiological measures for each group).

Physiological data associated with an experimental design such as the current one typically employ the use of classical ANOVA or ANCOVA methods that estimate parameters using least squares estimation. However, given that outliers are often present in physiological data, which is the case in the current paper, it would be optimal to consider alternative procedures for estimating parameters that are more robust against the presence of outliers. Rank estimation of regression coefficients using iterated reweighted least squares is one such technique for estimating parameters that has been shown to be relatively insensitive to the presence of outliers in data (Hettmansperger & McKean, 2011). Therefore, the current paper's analyses implemented this method, using R statistical software, due to violated assumptions of normality and the presences of outliers in the data and as a result provides a more appropriate model fitting of the HR, RSA, SCL, and SCR data. A brief introduction to the rank estimation of regression coefficients using iterated reweighted least squares is given below (see Sievers & Abebe, 2004 for a more detailed explanation of the method as well as to request R code, see Appendix E for sample R code for heart rate data).

First, we consider the linear model

$$y_i = \alpha + x_i\beta + e_i, \qquad\qquad 1 \le i \le n$$

with rank estimate of β, $\hat{\beta}_n$, proposed by Jaeckel (1972) that minimizes the dispersion function

$$D_n(\mathbf{b}) := \sum_{i=1}^{n} \Phi\left(\frac{R(r_i(\mathbf{b}))}{n+1}\right) r_i(\mathbf{b})$$

where $r_i(b)$ are the model residuals, $R(r_i(\mathrm{b}))$ are the ranks of the residuals, i =1, 2, ….n, and $\Phi(u)$ is a nondecreasing score generating function, usually standardized so that $\int \phi = 0$ and $\int \phi^2 = 1$. The estimation of $\hat{\beta}_n$ in the manner proposed by Jaeckel can be formulated into a weighted least squares estimation with nonnegative weights by centering the residuals. This formulation leads to a convex function that is minimized through iteratively reweighting the residuals depending on the score generating function. In the analyses to follow, Wilcoxon scores given by $\phi(u) = \sqrt{12}(u - 0.5)$ are used to generate the rank estimate of the regression coefficients using the iterated reweighted least squares method. Using a modified version of linear modeling (lm) that incorporates the new beta estimates based on the weighted residuals, R statistical software (R Core Team, 2015) is then able to output familiar ANCOVA tables with which to draw statistical conclusions about the data.

Heart Rate. Regarding heart rate (HR), measured in beats per minute (BPM), ANCOVA results did not show a significant effect of group, though a trend towards significance was present $F(2, 76) = 2.666$, $p = .076$ (see Table 7 for means and standard deviations). However, results indicated a significant interaction between group and baseline, $F(2, 76) =$

3.639, p = .031 (see Table 8 for corresponding ANOVA table). A lack of significant effect for group does not lend support to the hypothesis that the positive group would exhibit different HR during test. However, the presence of a significant interaction indicates that the effect of group depends on the level of baseline HR. Further investigation of the interaction effect showed that the slope relating HR baseline and test HR for the neutral (b = 1.118) condition was different from the slopes of the positive (b = 0.860) and negative (b = 0.853) conditions. All conditions had a positive relation of HR baseline and test HR. For example, at lower levels of baseline the neutral condition displayed lower HRs compared to the negative and positive conditions. At higher levels of baseline HRs the neutral condition displayed higher HRs than the negative and positive conditions (see Figure 2). In this case, positive film viewing did not quell the effects of subsequent negative film viewing. Thus, for HR, positive emotions did not protect against an increase in HR compared to the negative group.

Respiratory Sinus Arrhythmia. The ANCOVA results for respiratory sinus arrhythmia (RSA), measured in volts, did not show a significant effect of group, $F(2, 76) = 0.057$, $p = .945$, nor a significant interaction of group and baseline, $F(2, 76) = 0.408$, $p = .667$ (see Table 7 for means and standard deviations and Table 9 for corresponding ANOVA table). The RSA data did not support the hypothesis that the positive (b = 0.818) group would show significantly different levels of RSA during test than the negative (b = 0.660) and neutral (b = 0.736) groups. For RSA, the positive film viewing, again, did not quell the effects of subsequent negative film viewing. Thus, positive emotions did not protect against change in RSA compared to the negative and neutral groups.

Skin Conductance Level. For skin conductance level (SCL), ANCOVA results showed a significant effect of group, $F(2, 76) = 5.314$, $p = .007$, as well as a significant interaction of group and baseline, $F(2, 76) = 6.890$, $p = .002$ (see Table 7 for means and standard deviations and Table 10 for corresponding ANOVA table). These results support the hypothesis that the groups would show significantly different SCLs during test; though not in the direction expected. It was expected that the positive condition, compared to the negative and neutral conditions, would exhibit lower SCLs during test. Instead, the positive condition led to increased SCLs during test compared to the negative and neutral conditions (see Figure 3). However, these results should be interpreted with caution given the significant interaction between condition and baseline. Specifically, for lower baseline SCLs, the positive (with baseline vs. test slope of b = 1.268) condition led to a decrease in SCL, but for higher baseline SCLs the positive condition led to increased SCLs at test. The neutral (b = 1.086) and negative (b = 1.092) conditions behaved similarly across the range of baseline SCLs.

Skin Conductance Responses. Results from ANCOVA analyses regarding SCRs, measured as the average number of responses, showed a significant effect of group, $F(2, 76) = 28.959$, $p = <.001$ as well as a significant interaction of group and baseline, $F(2, 76) = 250.279$, $p = <.001$ (see Table 7 for means and standard deviations and Table 11 for corresponding ANOVA table). These results support the hypothesis that the conditions would elicit significantly different numbers of SCRs during test. Similar to SCL, the direction observed did not align with the hypothesized direction. The hypothesized direction involved lower numbers of SCRs for the positive group compared to the negative and neutral groups during the second set of film stimuli. Instead, the neutral condition led to fewer skin conductance responses than the positive and negative conditions. These results should again be interpreted with caution given the significant interaction between condition and baseline. Specifically, for lower baseline SCRs, the positive (with slope between baseline and test time of $b = 0.804$) and negative ($b = 0.776$) conditions led to a decrease in SCRs, but for higher baseline SCRs the positive and negative conditions led to increased SCRs at test compared to the neutral condition ($b = 0.383$; see Figure 4).

Physiological Resilience

Generally, the expectation was that individuals viewing the positive emotion-eliciting film clips would return back to baseline levels of physiological functioning quicker than those in either the neutral or negative film viewing groups. The experimental design did not allow for a specific waiting period assessing when physiological levels return to baseline. However, given that all participants underwent the same sequence of events (i.e., the global-local task and modified Twenty Statements Test) following the second set of film stimuli, this expectation was assessed using the progression of the physiological measurements starting from the end of the second set of film stimuli and continuing to the end of the experiment as determined by participants' time taken to finish the cognitive tasks.

The analyses for physiological resilience utilized survival analysis techniques that implement a cox proportional hazard model fitting for the data. In this case, covariate inputs for the model included participants' 2 minute baseline average HR and SCL and the defined time to event was the number of seconds elapsed until returning back to that subject's 2-minute baseline average and remaining there for 5 consecutive seconds. Right censoring was used for participants who did not return back to baseline within the experimental timeframe. Censored observations occur when the information about their survival time is incomplete. Two measures were of interest for investigating physiological resilience, HR and SCL.

Heart Rate. Heart rate data consisted of four censored observations and one deleted observation due to equipment malfunction. The chi-square test did not indicate a difference in the odds of returning back to baseline as a result of group assignment, $\chi^2(2, N = 81) = 0.928$, $p = .629$. Specifically, when comparing the negative condition with the neutral and positive conditions, a trend toward significance in the odds of returning back to baseline HR did not emerge, ($z = -0.971$, $p = .331$, $z = -0.152$, $p = .879$, respectively; see Table 12 for corresponding Cox regression table and Table 13 for analysis of deviance table). Figure 5 depicts the survival curves for a baseline HR of 52, the median baseline HR, and a baseline HR of 100. Qualitatively, fixing baseline HR at the median level resulted in the neutral group appearing to return back to baseline slower than the other two groups, but not at a significantly slower rate. It was also clear that most participants returned to baseline HR levels within roughly 100 seconds. Comparing, the three different baseline survival plots illustrates the stable pattern across the range of baseline HR values.

Skin Conductance Level. The SCL data included 58 censored observations and one deleted observation due to equipment malfunction. Overall, the likelihood ratio test did not indicate a difference in the odds of returning back to baseline related among the conditions, χ^2(2,

N = 81) = 1.318, p = .517. Similar to HR, when comparing the negative condition with the neutral and positive conditions, a trend toward significance in the odds of returning back to baseline HR did not emerge, (z = 0.573, p = .567, z = -0.463, p = .643, respectively, see Table 14 for corresponding cox regression table and Table 15 for analysis of deviance table). Figure 6 depicts the survival curve for baseline SCL of 200, median SCL, and baseline SCL of 800. Qualitatively, fixing baseline SCL at the median level resulted in the positive group appearing to return back to baseline slower than the negative group which was slower to return than the neutral group. It was also clear that most participants did not return to baseline SCL levels within the experimental timeframe making it difficult to draw inferential conclusions. Comparing the three different baseline survival plots demonstrates that the patterns remains similar across the range of baseline SCL values.

Physiology and Personality Characteristics

To measure relation between self-reported optimism and self-reported resilience with participants' HR, RSA, SCL, and SCR during the baseline and the test period in effort to investigate the need for moderation analyses (see Table 16), involved implementing correlation analyses. For HR, no significant correlations were present between baseline HR and resilience, $r(82)$ = .196, p = .079, baseline HR and optimism, $r(82)$ = .210, p = .060, test HR and resilience, $r(82)$ = .160, p = .154, test HR and optimism, $r(82)$ = .203, p = .069. Likewise, for RSA, no significant correlations emerged between baseline RSA and resilience, $r(82)$ = -.098, p = .382, baseline RSA and optimism, $r(82)$ = -.083, p = .461, and test RSA and resilience, $r(82)$ = -.153, p

= .174, and test RSA and optimism, *r*(82) = -.110, *p* = .326. In addition, for SCL, no significant correlations occurred between baseline SCL and resilience, *r*(82) = -.126, *p* = .261, baseline SCL and optimism, *r*(82) = -.107, *p* = .341, test SCL and resilience, *r*(82) = -.098, *p* = .382, and test SCL and optimism, *r*(82) = -.108, *p* = .339. Last, for SCR, no significant correlations were present between baseline SCRs and resilience, *r*(82) = .110, *p* = .329, baseline SCRs and optimism, *r*(82) = .145, *p* = .196, test SCRs and resilience, *r*(82) = .130, *p* = .247, and test SCRs and optimism, *r*(82) = .004, *p* = .975.

Discussion

This dissertation assessed the effect of positive antecedents on individuals' behavior within the realm of physiological and cognitive reactions to emotion induction. Theories of positive emotions highlight the roles of positive emotions in broadening and building people's thought-action repertoires, physical and intellectual resources, and social and psychological resources (Fredrickson, 1998; 2001). Additionally, there is evidence that positive emotions hasten recovery from lingering effects of negative emotions (Fredrickson et al., 2000) and play a role in psychological resilience (Fredrickson 2001; Tugade & Fredrickson, 2004).

Capitalizing on these ideas and evidence, I investigated the idea that positive emotions may also have a protective role on cognitive and physiological responses when experienced immediately before negative emotions. Specifically, my research focused on determining if positive emotions protect people against heightened physiological responses and prevent narrowed cognitive responses that negative emotions bring about. Methodologically, I attempted to induce participants' to feel positive and negative emotions in combination with continually measuring an array of physiological measures, including heart rate, respiratory sinus arrhythmia, skin conductance level, and skin conductance responses. Additionally, similar to Fredrickson and Branigan (2005), I used a global-local processing task (Navon, 1977) and a modified version of the Twenty Statements Test (Kuhn & McPartland, 1954) for the purpose of assessing whether the positive emotions' ability to broaden individuals' thinking remains after the exposure to negative emotions.

I hypothesized that participants induced to feel positive emotions prior to the induction of negative emotions would retain broader thinking (i.e. exhibit greater accuracy and speed on global decisions on the global-local processing task and more responses on the Twenty Statement Test) than participants induced to feel neutral or negative emotions prior to negative emotion induction. For the global-local visual processing task, the positive group did not exhibit greater accuracy on the global instruction trials than either the negative or neutral groups. Similarly, the positive group did not respond more quickly on global trials than either the negative or neutral groups. Both assessments, accuracy and response time, showed that all groups performed similarly and results did not differ depending on the type of decision required (i.e. global versus local). For the Twenty Statements Test, participants in the positive group did not produce more responses as compared to the negative and neutral groups. In addition, the negative and neutral groups did not differ in the number of responses given.

Results on the global-local visual processing task and the Twenty Statements Test failed to support my hypotheses that positive emotions would protect against narrowed thinking associated with negative emotions. My results are contrary to Fredrickson's and Branigan's (2005) research that indicated people induced to feel positive emotions make more global choices than those in negative of neutral states as well as produce more responses on the Twenty Statements Test. However, the global-local visual processing task used in the current paper was not identical to Fredrickson's and Branigan's (2005) task which, in part, could be a possible explanation for the divergent results. Fredrickson's and Branigan's (2005) task allowed participants to choose either a global or local configuration of elements, but the task in the current research forced participants to make either a global or local choice which resulted in extra pressure on the participant to make a correct response. The added stress of making correct responses may have restricted the beneficial effects of positive emotions on broadened thinking. Thus, the broadening effects of positive emotions appears dependent on the required stress of the global-local visual processing task.

Another explanation for the current paper's divergent results is related to the experimental set up. Studies related to the broadening theory of positive emotions only compared one emotional experience with a different emotional experience (Estrada, Isen, & Young, 1997; Fredrickson & Branigan, 2005; Isen, Daubman, & Nowicki, 1987; Isen, Rosenzweig, & Young, 1991; Isen, Johnson, Mertz, & Robinson, 1985; and Isen & Daubman, 1984). The current paper uniquely examined how sequences of emotional experiences interact with broadened thinking. The results presented here show that the robust effect of positive emotions broadening thinking does not translate into experiences in which a negative emotional experience occurs in between the positive emotional experience and the cognitive testing period. However, this effect may be so small that the current study may have lacked sufficient power to detect the protective role of positive emotions. Consequently further investigation is warranted.

With respect to physiological effects, I hypothesized that individuals viewing positive emotion eliciting film clips immediately before viewing negative emotion eliciting film clips would exhibit lower physiological arousal to the negative clips than individuals who viewed either neutral or negative emotion clips before watching the second set of negative film clips. This hypothesis aimed to illustrate the physiological protective effects of positive emotions compared to neutral and negative emotions. The hypothesis was not supported among any of the physiological measures.

For HR data, the participants' group assignment did not emerge as a significant contributor to differences in HR during the test phase (i.e. during the second set of video clips) despite controlling for the effects of participants' baseline HR levels. In other words, participants viewing positive films prior to viewing negative films were not protected against an increase in HR compared to participants in either the negative or neutral groups. However, given that the effect of group depends on the level of baseline, the protective abilities of positive emotions are dependent on baseline heart rate levels. For example, at higher levels of baseline heart rate, the positive and negative groups had lower heart rate levels at test compared to the neutral group. At the least, some emotional manipulation, either positive or negative, was more effective at preventing an increase in heart rate at test than neutral emotion induction at higher levels of baseline. Interestingly, at lower levels of baseline heart rate the neutral group exhibited lower heart rates at test than both the negative and positive groups. These results were unexpected findings given that previous research indicates a relative lack of physiological arousal related to positive emotions (Levenson, 1992; Levenson, Ekman, & Friesen, 1990; Levenson, Ekman, Heider, & Friesen, 1991), which would have resulted in the positive and neutral groups having similar levels of heart rate at test. Thus, results from the HR data support the fact that negative events and negative emotions, have stronger influence over neutral or good events as well as neutral or positive emotions (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001, for a review; Pratto & John, 1991; Taylor, 1991; Wentura, Rothermund, & Bak, 2000) but only at lower levels of baseline heart rate.

Similar to the HR, group assignment did not affect RSA levels during the test period. Therefore, positive emotion induction did not lead to different levels of RSA compared to the negative and neutral groups. When exploring the pattern of RSA data across all events in the experiment, group and RSA did not appear related, implying that the groups behaved similarly throughout the time course of the experiment. These results, as in the case of HR, also support evidence displaying the stronger influence of negative emotions over positive emotions (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001, for a review; Pratto & John, 1991; Taylor, 1991; Wentura, Rothermund, & Bak, 2000).

For SCL and SCRs, the relation between group and SCL materialized as well as the relation between group and SCRs; however, the relation was not in the direction expected. The anticipated finding involved the positive group exhibiting lower numbers of SCRs and lower

SCLs than the negative and neutral groups during the test period. Instead, the negative and neutral groups exhibited lower SCLs during the test period than the positive group, suggesting that negative emotions act as their own protection against subsequent negative emotion eliciting experiences. Negative emotions acting as buffers for subsequent negative emotions is contrary to evidence indicating positive emotions play the buffering role against later negative events (Bastian, Kuppens, De Roover, & Diener, 2014; Cohn, Fredrickson, Brown, Mikels, & Conway, 2011; Mak, Ng, & Wong, 2011). Unexpectedly, the neutral group exhibited similar SCLs to the negative group at test in addition to having lower SCLs than the positive group. Perhaps this finding can be attributed to the fact that on a valence scale going from neutral to negative affective states requires less physical adaptation than moving from a positive state to a negative state. Skin conductance response data also indicated that at higher numbers of baseline SCRs, the neutral group exhibits lower numbers of SCRs than the positive and negative groups. Again, a deviation from the notion that positive emotions play a buffering role against subsequent negative events emerged (Bastian et al., 2014; Cohn et al., 2011; Mak, Ng, & Wong, 2011). In the selection of video clips of the positive and negative emotion eliciting video clips, the arousal level was statistically equated to control for any extraneous arousal effects. Consequently, the negative group could be displaying lower SCLs during the test period as a result of adapting to the arousal level elicited during the treatment phase. Alternatively, it is possible that the mechanisms by which positive emotions exert their effects are more complex than the specific autonomic measures employed in this study. Thus, future work should incorporate additional physiological measures, such as electroencephalography (EEG) and impedance cardiography

(IC) as well as explore neural mechanisms to better understand the possible manifestations that positive emotions have.

I also hypothesized that individuals viewing the positive emotion clips first would return back faster to their baseline physiological levels after watching the negative emotions clips than those individuals in either the neutral or negative film viewing groups. This hypothesis sought to illustrate the notion that positive emotions fuel psychological resilience and associatively, physiological resilience. Measures of interest for physiological resilience included HR and SCL.

The physiological resilience hypothesis for the positive group was not supported for either physiological measure, HR or SCL. Despite controlling for differences in baseline HR and SCLs among participants, all groups returned back to baseline at similar rates. Of note, for SCL, the majority of the observations needed censoring, thus, the conclusions drawn from the SCL data related to returning back to baseline should be evaluated with caution. The lack of group influence on physiological resilience when a negative emotional experience occurs following the positive emotional experience supports the notion that negative emotional experiences take precedence over positive emotional experiences (Gable & Haidt, 2005) in addition to being processed more thoroughly (Baumeister et al., 2001; Pratto & John, 1991; Taylor, 1991; Wentura, Rothermund, & Bak, 2000). These data indicate that the undoing hypothesis (Fredrickson et al., 2000) is only supported when the negative emotional experience occurs prior to the positive emotional experience.

Taken together, the results presented illustrate the power of negative emotions to demand attention (Seligman, Parks, & Steen, 2004), exhibit a stronger influence over good events (Pratto

& John, 1991; Taylor, 1991; Wentura, Rothermund, & Bak, 2000) and be processed more thoroughly (Baumeister et al., 2001). Negative emotions exhibit physiological and cognitive influence in part due to the survival success of addressing potential threats (Massimini & Delle Fave, 2000) and the health implications, such as increased risk for heart disease, anxiety, and depression, if attention is not paid to negative emotions (Beck, Emery, & Greenberg, 2005; Fredrickson et al., 2000; Glassman & Shapiro, 1998). In contrast, the results were contrary to the posited notion that positive emotions protect against heightened physiological arousal and narrowed thinking that negative emotions elicit.

The current paper investigated the more immediate protective effects of positive emotions, as a consequence, resultant long-term effects cannot be gleaned from such a study. Previous research has suggested that the protective or preventative abilities of positive emotions lies more in the building of resources that can be drawn on when needed (Fredrickson et al., 2001). In addition, the building of protective reserves may require experiencing positive emotions over a longer time period in order for the benefits of positive emotions to take full effect. Simply being induced to feel positive emotions just before having a negative emotional experience may not have allowed participants enough time to fully draw on the reserve the positive emotion induction created or the positive emotion reserve did not have time to solidify. Future research should explore when positive emotional experiences become engrained in memory and become ready for use when needed. Moreover, further investigations are needed to determine factors that cause people to draw on their physical and psychological resources as well as a better understanding of what experiences prove most useful when encountering hard times.

Chapter 5

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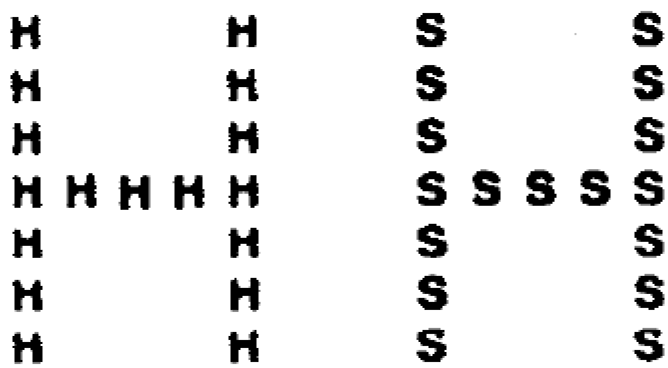
Appendix A

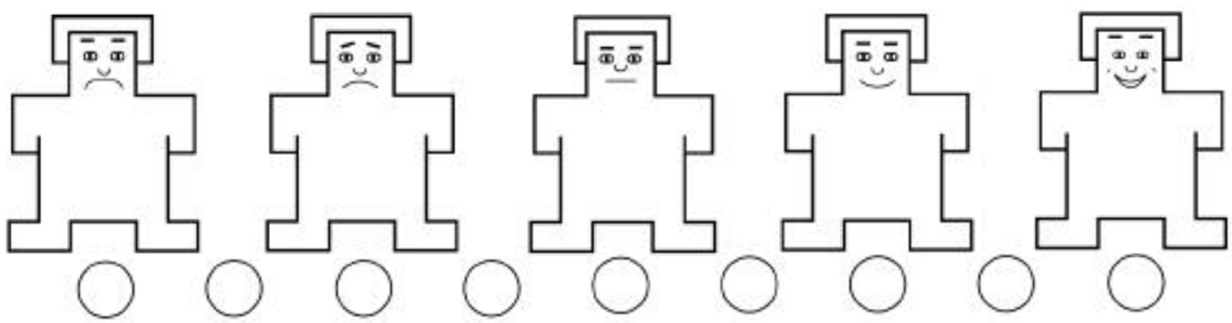
Examples of global-local visual processing task stimuli



Appendix B

Self-Assessment Manikin – Computer Screen Adapted Version

How are you feeling right now?

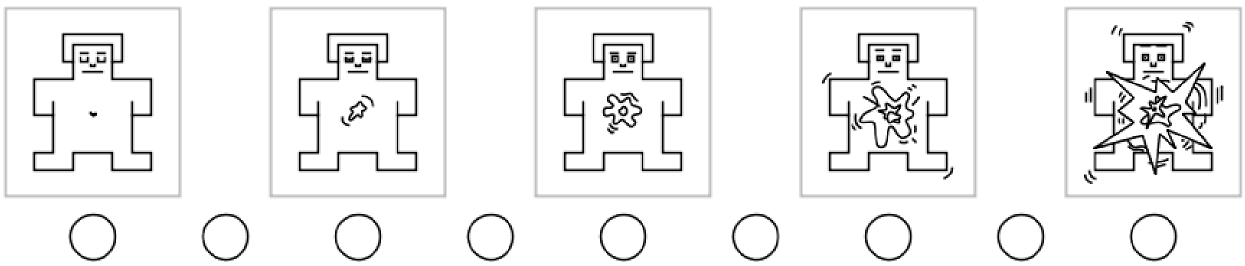


Very unpleasant **Very pleasant**

1 2 3 4 5 6 7 8 9

Please type a number to indicate your valence.

How aroused are you feeling right now?



Not aroused **Very aroused**

1 2 3 4 5 6 7 8 9

Please type a number to indicate your arousal level.

Appendix C

Modified Twenty Statements Test

Twenty Statement Test (TST)

Take a moment to imagine being in a situation yourself in which this particular emotion would arise (the emotion you felt after viewing all the videos). Concentrate on all the emotion you would feel and live it as vividly and as deeply as possible. *Given this feeling*, please *list* all the things you would like to do *right now*.

1. ____

2. ____

3. ____

4. ____

5. ____

6. ____

7. ____

8. ____

9. ____

10. ____

11. ____

12. ____

13. ____

14. ____

15. ____

16. ____

17. ____

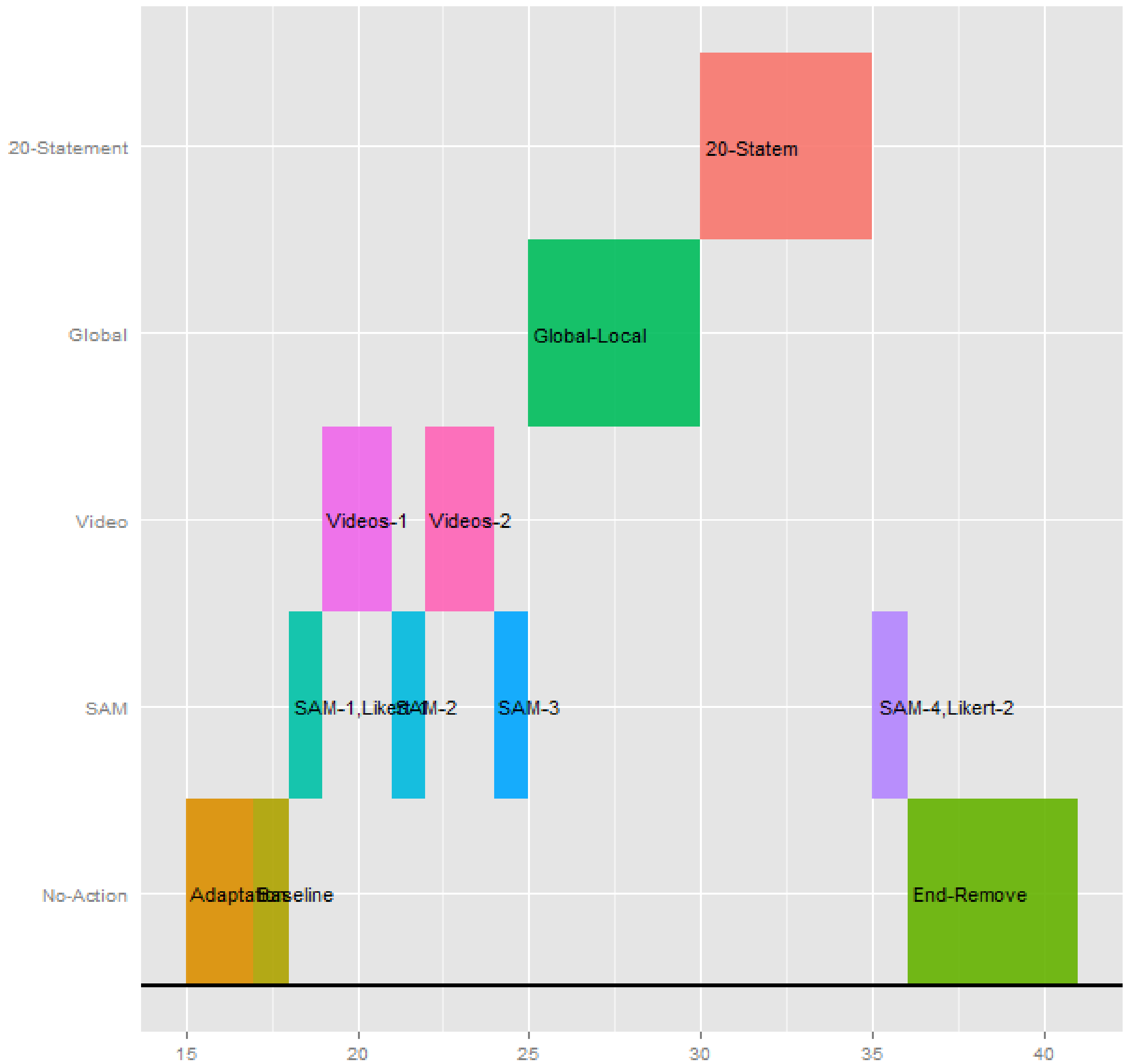
18. ____

19. ____

20. ____

Appendix D

Experiment Timeline



Appendix E

R Code for Heart Rate Data

```
HR <- read.csv("Master - HR.csv")
names(HR) <- c("sub", "condition", "base", "trt", "sam1", "resp", "sam2", "cog")

HR.neu <- subset(HR, condition == "Neutral")
HR.pos <- subset(HR, condition == "Positive")
HR.neg <- subset(HR, condition == "Negative")

## Exploratory plot of response vs baseline by condition (rank)
library(Rfit)
plot(HR$base,HR$resp, col=HR$condition, xlab="Baseline", ylab="Response", main="Rank")
abline(rfit(resp~base, data=HR.neu), col=HR.neu$condition)
abline(rfit(resp~base, data=HR.neg), col=HR.neg$condition)
abline(rfit(resp~base, data=HR.pos), col=HR.pos$condition)

rfit1<-rfit(resp~base, data=HR.neu); summary(rfit1)
rfit2<-rfit(resp~base, data=HR.neg); summary(rfit2)
rfit3<-rfit(resp~base, data=HR.pos); summary(rfit3)

source("ranklm.R")
# phi.w
intlm.r <- ranklm(scale(resp) ~ condition * scale(base), data=HR, phi=phi.w)
summary(intlm.r)
anova(intlm.r)
```

```
par(mfrow=c(2,2))

plot(intlm.r, col=HR$condition)

Anova(intlm.r, type = 'III')



## Prediction ##

newdata <- data.frame(base = rep(seq(from = min(HR$base), to = max(HR$base), length.out = 100), 3), condition = factor(rep(1:3, each = 100), levels = 1:3, labels =levels(HR$condition)))

## Rank prediction

rpred <- predict(intlm.r, newdata, se.fit=TRUE)

newdata$pred.r <- rpred$fit

newdata$ll.r <- rpred$fit - 1.96*rpred$se.fit

newdata$uu.r <- rpred$fit + 1.96*rpred$se.fit


library(ggplot2)

## Rank prediction plot

ggplot(newdata, aes(base, pred.r)) +

  geom_line(aes(colour = condition), size = 1) +

  labs(x = "Baseline", y = "Rank Predicted Response")
```

Tables

Table 1

Means and standard deviations for correct responses (Maximum = 12) on the global-local visual processing task.

Group	Global		Local	
	M	SD	M	SD
Negative (N = 27)	11.30	1.17	11.33	1.21
Neutral (N = 27)	11.22	2.31	10.70	2.71
Positive (N = 28)	11.93	.26	11.46	1.20

Table 2

ANOVA table for the comparison of emotion group and accuracy on the global-local visual processing task.

		SS	*df*	*MSE*	*F*	*p*	η_p^2	Power
Between								
	Group	14.806	2	7.403	1.650	.199	.040	.338
	Error	354.413	79	4.486				
Within								
	Scope	4.074	1	4.074	3.563	.063	.043	.462
	Group*Scope	2.544	2	1.272	1.112	.334	.027	.239
	Error	90.334	79	1.143				

Table 3

Means and standard deviations for response times (in milliseconds) on the global-local visual processing task.

Group	Global		Local	
	M	SD	M	SD
Negative (N = 27)	1409.76	446.37	1405.83	435.84
Neutral (N = 27)	1349.73	539.59	1317.17	487.54
Positive (N = 28)	1519.12	436.18	1459.87	464.02

Table 4

ANOVA table for the comparison of response time by emotion group on the global-local visual processing task.

		SS	*df*	*MSE*	*F*	*p*	η_p^2	Power
Between								
	Group	667596.078	2	333798.039	.874	.421	.022	.196
	Error	30166930.010	79	38185930.010				
Within								
	Scope	42305.142	1	42305.142	.685	.410	.009	.129
	Group*Scope	21520.563	2	10760.281	.174	.840	.004	.076
	Error	4878676.860	79	61755.403				

Table 5

Means and standard deviations for the number of responses on the Twenty Statements Test.

Group	TST	
	M	SD
Negative (N = 27)	9.04	4.06
Neutral (N = 27)	8.11	3.66
Positive (N = 28)	10.57	4.04

Table 6

Means and standard deviations for baseline heart rate, respiratory sinus arrhythmia, skin conductance level, and skin conductance response for each group.

Group	HR		RSA		SCL		SCR	
	M	SD	M	SD	M	SD	M	SD
Negative (N = 27)	79.24	12.09	6.56	1.27	385.04	237.76	22.00	39.81
Neutral (N = 27)	77.18	9.10	7.34	1.22	517.88	290.38	20.04	49.96
Positive (N = 28)	79.54	10.32	7.37	1.83	407.31	287.09	23.75	72.79

Table 7

Means and standard deviations for heart rate, respiratory sinus arrhythmia, skin conductance level, and skin conductance response, during the second set of videos clips (i.e. test period).

Group	HR		RSA		SCL		SCR	
	M	SD	M	SD	M	SD	M	SD
Negative (N = 27)	74.69	11.08	6.80	1.27	465.46	268.38	36.56	26.51
Neutral (N = 27)	74.75	10.91	7.42	1.35	621.08	324.85	44.76	22.23
Positive (N = 28)	77.67	13.11	7.25	1.63	517.84	325.20	43.13	22.32

Table 8

ANOVA table displaying the test of group assignment on heart rate during the second set of video clips (i.e. test period) while controlling for differences in baseline heart rate.

	SS	*df*	*MSE*	*F*	*p*
Condition	0.640	2	0.320	2.666	.076
Baseline	20.755	1	20.755	172.893	<.001
Condition*Baseline	0.874	2	0.437	3.639	.031
Error	9.123	76	0.120		

Table 9

ANOVA table displaying the test of group assignment on respiratory sinus arrhythmia during the second set of video clips (i.e. test period) while controlling for differences in baseline respiratory sinus arrhythmia.

	SS	*df*	*MSE*	*F*	*p*
Condition	0.033	2	0.017	0.057	.945
Baseline	6.840	1	6.840	23.223	<.001
Condition*Baseline	0.240	2	0.408	0.408	.667
Error	22.385	76	0.295		

Table 10

ANOVA table displaying the test of group assignment on skin conductance level during the second set of video clips (i.e. test period) while controlling for differences in baseline skin conductance levels.

	SS	*df*	*MSE*	*F*	*p*
Condition	0.330	2	0.165	5.314	.007
Baseline	15.441	1	15.441	496.720	<.001
Condition*Baseline	0.428	2	0.214	6.889	.002
Error	2.363	76	1.181		

Table 11

ANOVA table displaying the test of group assignment on skin conductance responses during the second set of video clips (i.e. test period) while controlling for differences in baseline skin conductance responses.

	SS	*df*	*MSE*	*F*	*p*
Condition	0.222	2	0.111	3.662	.030
Baseline	15.279	1	15.279	503.450	<.001
Condition*Baseline	3.529	2	1.765	58.143	<.001
Error	2.307	76	0.030		

Table 12

Cox's regression table for heart rate data using group assignment and baseline as explanatory variables (negative group was used as reference).

	Coefficient (b)	Standard Error	e^b	z	p	95.0% Confidence Interval for e^b
Neutral	-0.280	0.288	0.756	-0.971	.331	(0.430, 1.329)
Positive	-0.043	0.285	0.958	-0.152	.879	(0.547, 1.675)
Baseline	0.026	0.010	1.026	2.512	.012	(1.006, 1.047)

Table 13

Analysis of deviance table for Cox regression model of heart rate data with group assignment and baseline as explanatory variables.

	Loglikelihood	χ^2	*df*	*p*
NULL	-273.280			
Group	-272.820	0.928	2	.629
Baseline	-269.770	6.088	1	.014*

Note: *p <.05 **p <.01 ***p<.001

Table 14

Cox's regression table for skin conductance level data using group assignment and baseline as explanatory variables (negative group was used as reference).

	Coefficient (b)	Standard Error	e^b	z	p	95.0% Confidence Interval for e^b
Neutral	0.287	0.501	1.332	0.573	.567	(0.499, 3.554)
Positive	-0.260	0.561	0.771	-0.463	.643	(0.257, 2.315)
Baseline	0.001	0.001	1.001	1.040	.298	(0.999, 1.002)

Table 15

Analysis of deviance table for Cox regression model of skin conductance level data with group assignment and baseline as explanatory variables.

	Loglikelihood	χ^2	*df*	*p*
NULL	-97.281			
Group	-96.622	1.318	2	.517
Baseline	-96.087	1.070	1	.301

Note: $^{*}p < .05$ $^{**}p < .01$ $^{***}p < .001$

Table 16

Correlations among physiological measures and resilience and optimism, at baseline and test for all the groups.

n = 82

	Baseline				Test				Resilience
	HR	RSA	SCL	SCR	HR	RSA	SCL	SCR	
Resilience	.196	-.098	-.126	.110	.160	-.153	-.098	.130	
Optimism	.210	.083	-.107	.145	.203	-.110	-.108	.004	.662***

Note: *p <.05 **p <.01 ***p<.001

Figures

Figure 1

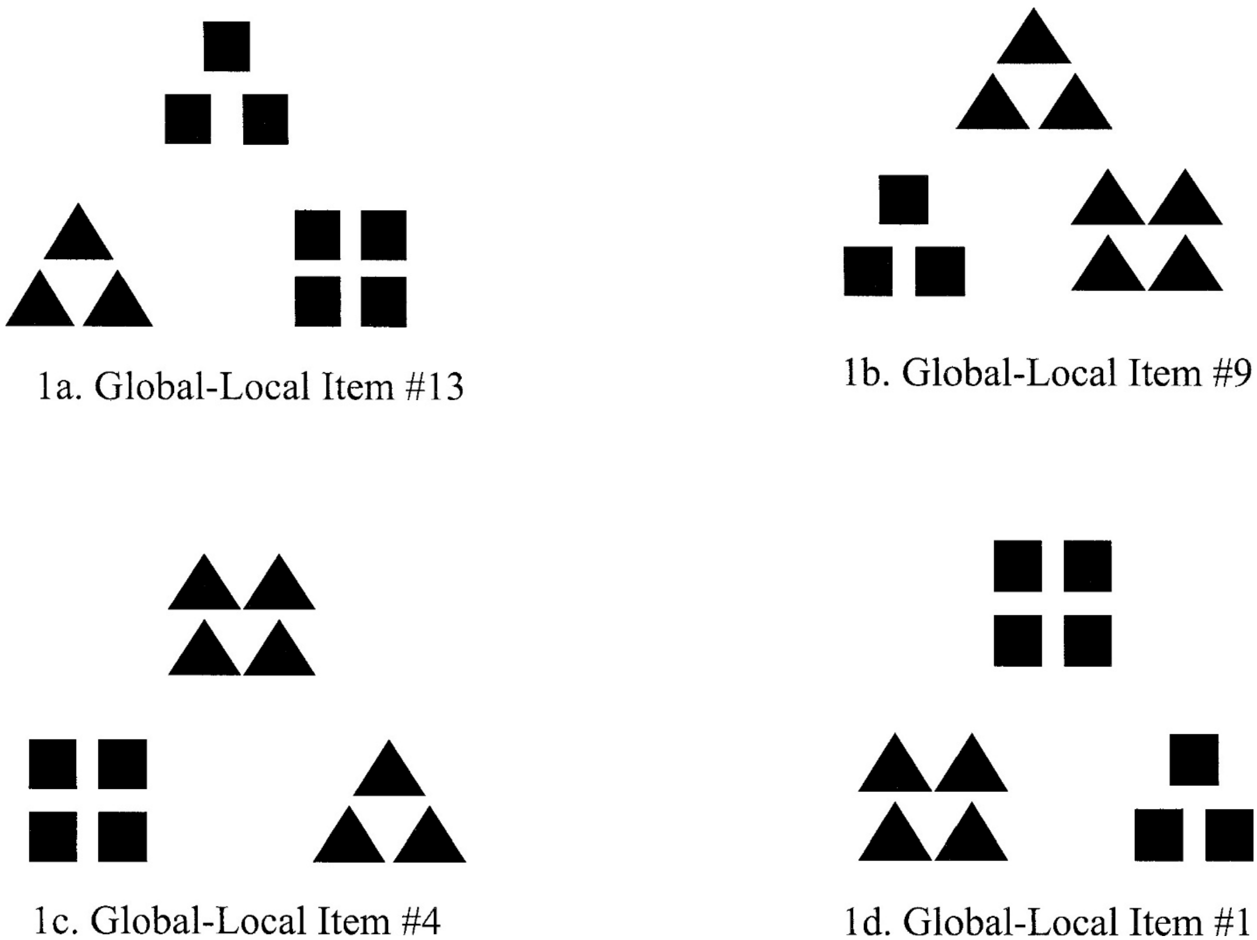


Figure 1. Examples of global-local items used in Fredrickson and Branigan (2005). Image reprinted from Fredrickson and Branigan (2005).

Figure 2

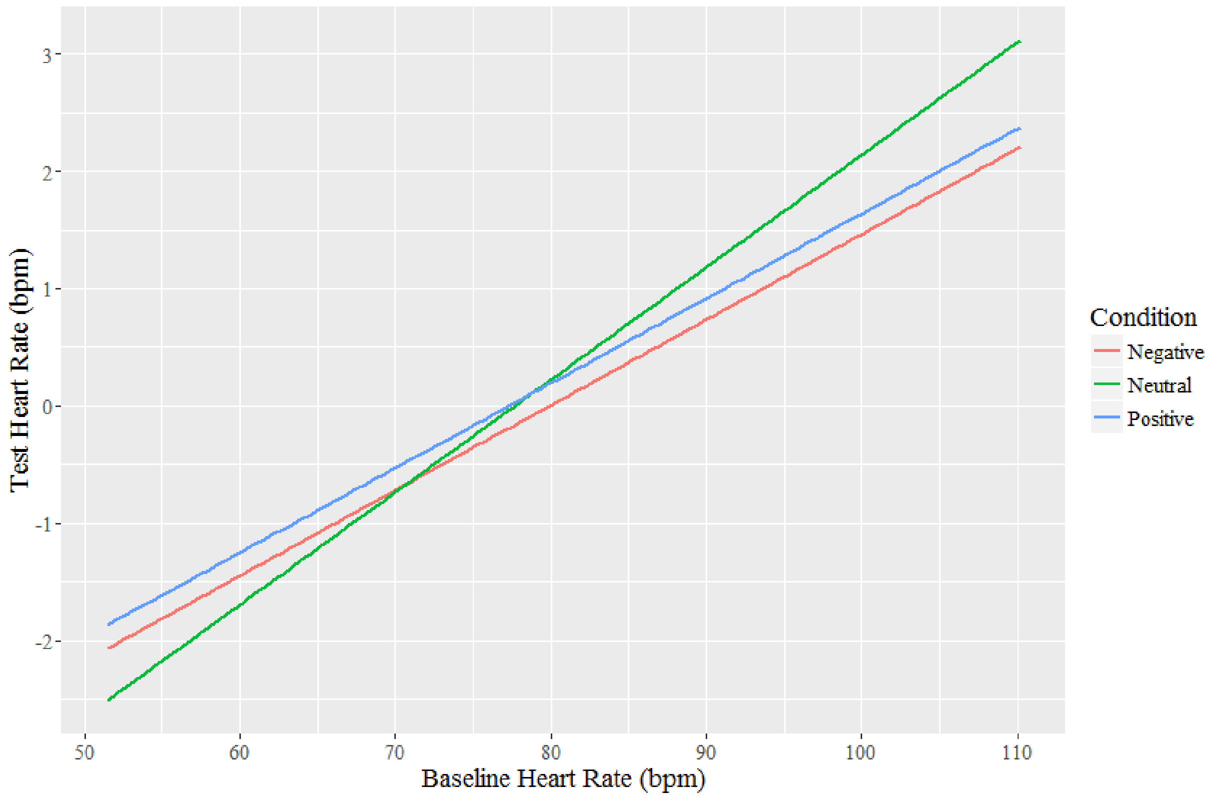


Figure 2. Predicted regression lines plot for heart rate data (measured in beats per minute; bpm) by condition.

Figure 3

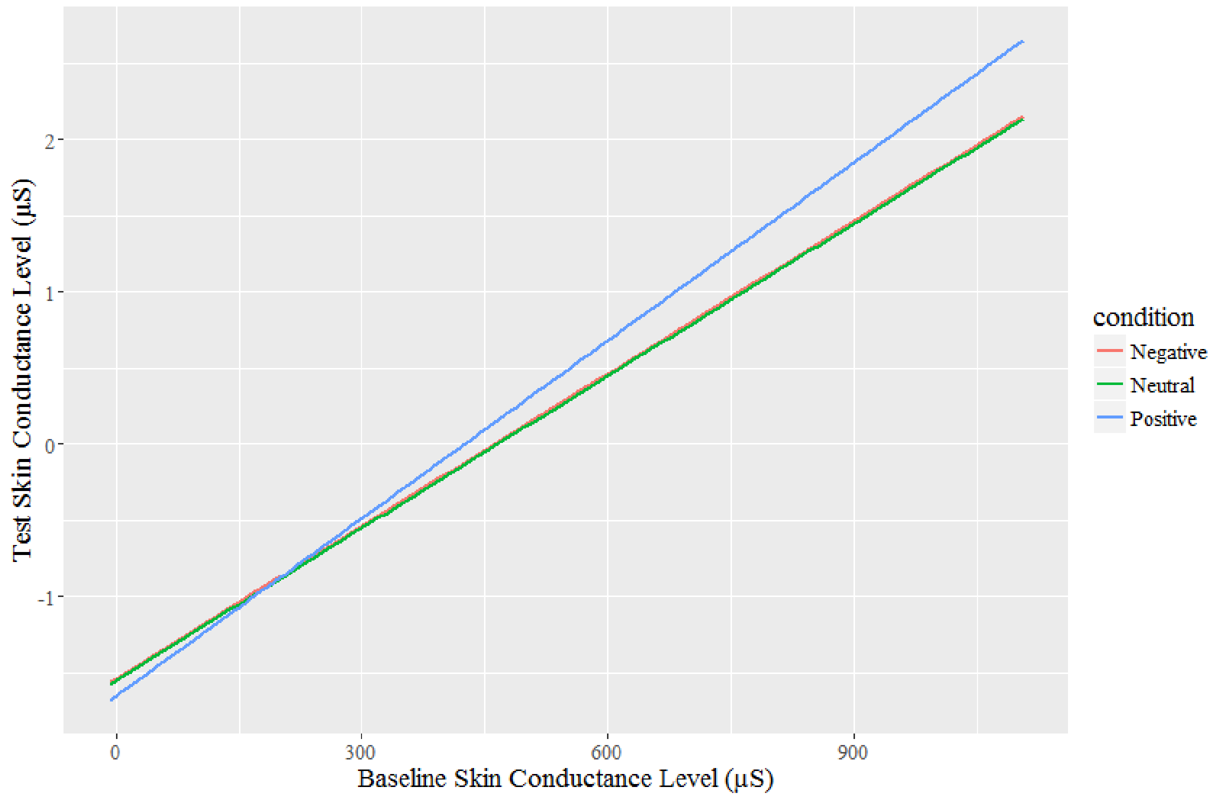


Figure 3. Predicted regression lines plot for skin conductance level data (measured in microSiemens; µS: reciprocal of Mega Ohms) by condition.

Figure 4

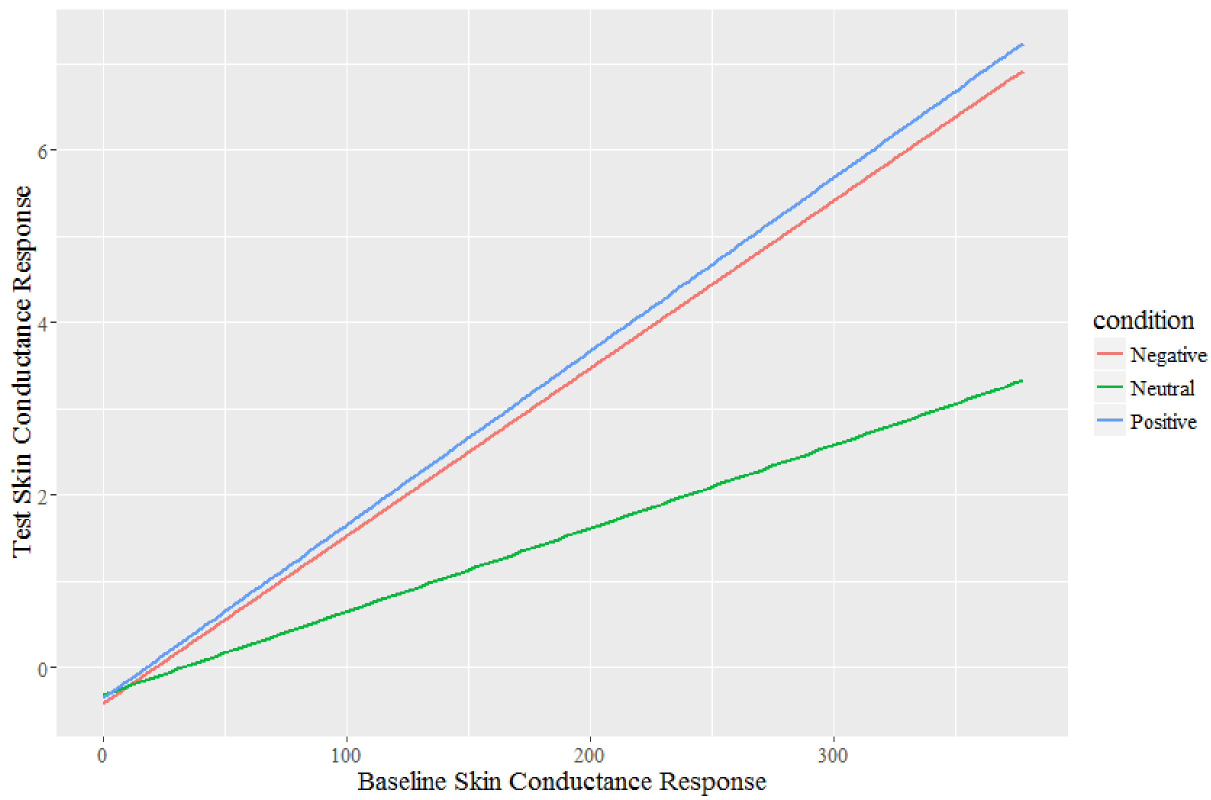


Figure 4. Predicted regression lines plot for skin conductance response data by condition.

Figure 5

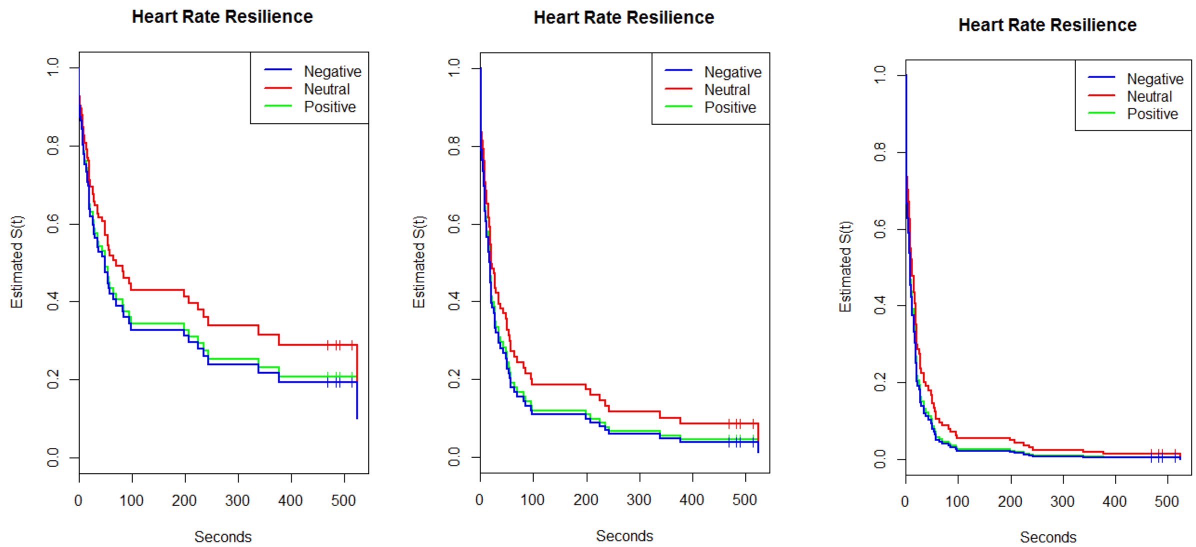


Figure 5. Survival curves for each group (Negative, Neutral, and Positive) at baseline heart rates of 52 (left), median (middle), and 100 (right).

Figure 6

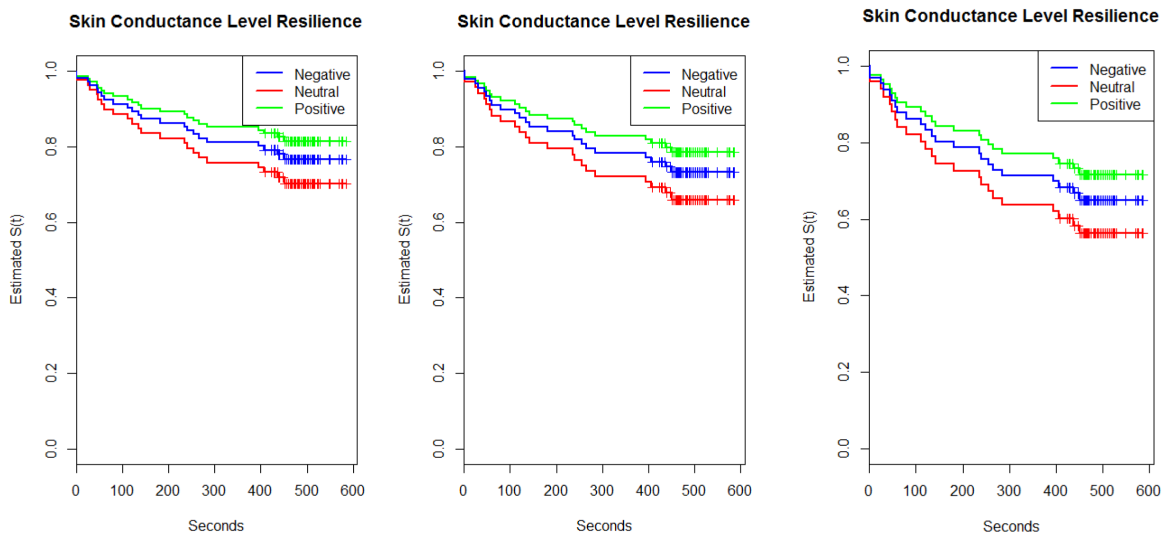


Figure 6. Survival curves for each group (Negative, Neutral, and Positive) at baseline skin conductance levels of 200 (left), median (middle), and 800 (right).