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THE ROLE OF STATE AND TRAIT POSITIVITY ON PHYSIOLOGICAL RESPONSE AND RECOVERY FROM NEGATIVE EMOTION

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Arezou Mortazavi

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The dissertation of Arezou Mortazavi was reviewed and approved* by:

Jose A. Soto
Associate Professor of Psychology
Dissertation Advisor
Chair of Committee

Koraly Perez-Edgar
Associate Professor of Psychology

Reginald Adams
Associate Professor of Psychology

Jennifer E. Graham-Engeland
Associate Professor of Biobehavioral Health

Melvin M. Mark
Professor of Psychology
Head of the Department of Psychology

*Signatures are on file in the Graduate School

ABSTRACT

There has been an increased interest in positive emotions within the last two decades and a surge in research supporting the notion that positive emotions have some beneficial impacts on physiology and health. In the current study, we investigate the role of state and trait positive emotions in reactivity and recovery from negative stimuli designed to elicit disgust. We expected both state and trait positive emotions to serve either a protective or buffering role, and to be associated with reduced physiological reactivity and better physiological recovery. We also expected facial expressions associated with positive emotion during presentation of the disgust stimuli to be associated with better physiological recovery, higher subjective ratings of positive emotions following the stimuli and lower subjective ratings of negative emotions following the stimuli. Results of the present study did not consistently demonstrate that trait positive emotion or the experience of state positive emotion prior to the stimulus provided a benefit to participants, in contrast to the Broaden-and-Build Hypothesis of positive emotions that informed the predictions the current study. Life satisfaction, trait positivity, and positive emotion ratings were related to some aspects of physiological responding, but not always in the directions hypothesized. The overall pattern of responding suggested that positivity may play a role in physiological responses that are, in part, tied to the parasympathetic nervous system, but may be less relevant or associated with increased sympathetic responding. The current study suggests that there is a need for further refinement of theories of positive emotions, and that consideration of culture may further illuminate in what situations and for whom these emotions serve a benefit.

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Chapter 1

INTRODUCTION

The Role of State and Trait Positivity on Physiological Response to and Recovery from Negative Emotion

Previous research has sought to clarify the ways in which psychological factors contribute to health. Much of this research has investigated responses to strong negative stimuli (Fredrickson, 1998; Chida & Steptoe, 2008), which can result in a variety of changes including physiological changes, behavioral changes, and changes in self-reported affective state. Investigation of physiological responses has distinguished between reactivity, or the magnitude of response, to negative stimuli, versus recovery from the effects of negative stimuli. Recovery represents the rate or degree to which subsequent physiological and psychological responses persist following the termination of the negative stimuli (Haynes, Gannon, Orimoto, O'Brien, & Brandt, 1991; Linden, Earle, Gerin, & Christenfeld, 1997). The investigation of recovery is timely given developments in our understanding of how the body responds to emotionally challenging situations. While some research findings indicate that both reactivity and recovery are related to harmful outcomes (Stewart & France, 2001; Treiber et al. 2001) other studies suggest that the physiological reactivity associated with such experiences actually may not be as detrimental to the body as failure to recover from such experiences (McGonigal, 2015; Steptoe & Marmot, 2005).

Positive emotions have previously been understudied relative to negative emotion in both the reactivity and recovery literature. However, there has been an increased interest in positive emotions within the last two decades and a surge in research supporting the notion that positive emotions have some beneficial impacts on physiology and health. There is some evidence that

the experience of positive emotions appears to temper the body's response to negative experiences. These findings are consistent with many current theories of positive emotion, which suggest that the experience of such emotion can be beneficial both in the short term and over time through the development of enduring resources that promote resilience in the face of challenges (Fredrickson, 2001; Zautra, Johnson, & Davis, 2005). However, other studies have indicated that positive emotions may sometimes be harmful or detrimental to physical health (Pressman & Cohen, 2005; Gruber, Mauss, & Tamir, 2011). Therefore, it is important to understand the contexts in which positive emotions are beneficial and how they provide such benefits.

One question that may be particularly important to investigate is how trait and state positivity uniquely contribute to beneficial physiological outcomes in the face of challenging emotional tasks. In this study, we investigate how trait and state positive emotions vary in their contribution to physiological reactivity and recovery. Specifically, we investigate how different forms and types of positive affectivity (self-reported trait and state positive affectivity as well as behavioral displays of positive affect) impact physiological responses to disgust as well as the physiological recovery process after the initial responses. We consider *elicited positivity* (defined here as positive affect that occurs in response to presented neutral and disgust-inducing stimuli) as well as *spontaneously occurring positivity* (operationalized as trait positive affect and state ratings of emotions prior to stimulus presentation). Finally, we test the ways in which these effects may be moderated by culture, given previous research indicating variation in cultural norms for the experience and expression of both positive and negative emotions (Ekman, 1972; Markus & Kitayama, 1994; Tsai, Knutson, & Fung, 2006), which appear to influence the long-

term adaptiveness of response styles within cultural groups (Soto, Perez, Kim, Lee, & Minnick, 2011).

Positive emotions and resiliency in relation to health and physiological responses

Recently, there has been a surge of interest in the contribution of positive emotions to health, physiology, and psychological outcomes such as effective coping (Tugade, Fredrickson, & Barrett, 2004). Effective coping refers to any cognitive or behavioral approach undertaken by an individual that serves to manage internal or external demands that challenge the individual's existing resources (Folkman, Lazarus, Gruen, & DeLongis, 1986). It appears that some individuals retain the capacity to experience positive emotions, even during times of high stress (Folkman, 1997; Folkman & Moskowitz, 2000). Additionally, because evidence suggests that most individuals tend to experience a baseline state of mild positivity (Deiner, Kanazawa, Suh, & Oishi, 2015), greater insight into the contribution of positive emotion to physical health may be relevant to a greater segment of the population as compared to a focus on negativity. Positive emotions have challenged previously established theories of emotion, which proposed that each emotion elicits a particular series of physiological and behavioral consequences (commonly referred to as an "action tendency") that aids in adaptation and promotes survival (Frijda, 1986; Frijda, Kuipers, & Schure, 1989; Lazarus, 1991). Positive emotions, in contrast, do not appear to be associated with specific action tendencies and, relative to negative emotions, generally appear to be characterized by less autonomic activation (Levenson, Ekman, & Friesen, 1990). As a result, in many emotion theories, positive emotions are viewed as less likely to motivate a specific pattern of behavior change that ultimately serves to regulate the experienced emotion (Carver & Scheier, 1990; Srull & Wyer, 1986).

However, in spite of this view, positive emotions have demonstrated important associations with a variety of health-related outcomes, including lower morbidity, decreased pain and pain sensitivity, increased longevity, and better self-reported health (Zillman, De Wied, King-Jablonski, & Jenzowsky, 1996; Pressman & Cohen, 2005; Stellar et al., 2015; Steptoe, Gibson, Hamer, & Wardle, 2007). In this literature, positive affect has been defined in numerous ways, ranging from ratings of discrete emotion terms such as happiness and enthusiasm to broader concepts including life satisfaction, well-being, cheerfulness, and optimism. Studies that have included an explicit focus on emotions have utilized both state measures assessing the intensity and frequency of positive emotion in the present moment as well as trait measures that investigate how the tendency to experience positive emotions is related to health-relevant outcomes. Other studies have conceptualized positive affect as an aggregate of many different positive emotions.

Recent work has also investigated the influence of positive emotion variability on such outcomes (Gruber, Kogan, Quoidbach, & Mauss, 2013). Positive emotion in these studies has typically been operationalized as the experience of happiness, while positive emotion variability has typically been operationalized as standard variation from an individual's mean level of self-rated happiness over a set period of time. Some studies have also included measurement of other positive emotions (including both high and low arousal positive emotions). For example, Gruber's study included repeated measurement of happiness, but also assessed excitement, a high arousal positive emotion. This study found that observation of variability in positive emotion provides additional information about the relationship between positive emotions and health over and above what can be learned from solely investigating mean levels of such emotions. Furthermore, it may be particularly important to consider this aspect of positive

emotions given its unique influence with psychological health. In this study, high variability in such emotions was associated with greater depression and anxiety as well as lower well-being as assessed by the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999) and life satisfaction as assessed by the Satisfaction with Life Scale (Diener, Emmons, Larson, & Griffin, 1985).

Despite the above finding, the literature on positive emotions has often supported the notion that such emotions appear to be associated with greater emotional and physiological resiliency in response to challenges and stressors. That is, individuals who more frequently experience positive emotions appear to possess and utilize superior coping methods (Folkman, 2008) and may experience less stress in response to challenging situations (Siu, Cheng, & Lui, 2015). Fredrickson and Joiner (2002) investigated the relationship of positive emotions and coping and found that state positive emotions were associated with greater utilization of creative and broad-minded coping strategies to problems. Additionally, they found that utilization of such strategies also predicted increased positive emotions five weeks later, suggesting that these factors interact in a cyclical way that ultimately develops higher resiliency. Similarly, Ong and colleagues (Ong, Bergeman, Bisconti, & Wallace, 2006) found that the occurrence of daily positive emotions moderates stress reactivity and mediates stress recovery in older adults. They concluded that highly resilient individuals appear to use positive emotions as a way to promote recovery from daily stress. Tugade and Fredrickson (2004) further clarified the nature of the relationship between positive emotions and resilience by investigating how highly resilient individuals cope when faced with a personal problem. Similar to the above study, results indicated that positive emotions mediated the relationship between psychological resilience and effective coping, defined as making meaning out of difficult circumstances. The authors concluded that the production of increased positive emotions results in a benefit to highly

resilient individuals. Thus, it appears that resilient individuals utilize positive emotions as a way to temper the psychological and physiological responses associated with negative experiences.

While the above research regarding resilient individuals supports the idea that positive emotions can be viewed as broadly protective or as a buffer from negative emotions, the evidence for this notion in relation to health and physiology is mixed. For example, positive emotions may lead to behavioral consequences that *negatively* impact health such as preventing individuals from recognizing and addressing signs of illness (Salovey, Rothman, Detweiler, & Steward, 2000). Based on the current literature, it appears that the beneficial impact of positive emotions varies according to the context in which the emotions are experienced as well as the extent of arousal (Larsen & Diener, 1992; Pressman & Cohen, 2005). This is consistent with a circumplex view of emotions, in which emotions are characterized based on two dimensions: valence (happy vs. sad) and arousal (high vs. low arousal) (Russell, 1980). Some high-arousal positive emotions, such as enthusiasm and excitement (Tsai et al., 2006), activate similar physiological responses associated with sympathetic nervous system activity as negative emotions, although not to the same magnitude. In some laboratory-based studies, intensely-experienced positive emotions have triggered physiological processes associated with long-term health risks related to immune, cardiovascular, and pulmonary functioning. Although naturalistic studies indicate that positive emotions in everyday life typically do not reach the level of intensity observed to trigger such responses, this suggests that high arousal positive emotion are associated with short-term physiological responses than can be harmful if experienced chronically. In contrast, positive emotions that do not reach this level of high arousal, such as amusement, or low arousal positive emotions (e.g., calmness and relaxation) are more frequently associated with beneficial health and physiological outcomes. Additionally, factors such as

increased variability in the experience of positive emotions, defined in one study as fluctuations in the intensity of positive emotion ratings in response to daily events, have been associated with poorer psychological health (Gruber et al., 2013), and highlight the need for more nuanced understanding of the relation between positive emotions and physiological consequences that may be relevant to long-term health outcomes. Because individuals tend to experience both positive and negative emotions in response to stress and negative experiences (Folkman, 1997; Folkman, 2008), it is important to understand the utility of positive emotions in regulating and recovering from these challenges.

The Broaden-and-Build Hypothesis

Much of the initial investigation of positive emotions and their influence on mental and physical health outcomes proceeded in an atheoretical manner (Pressman & Cohen, 2005). While proceeding with a theory in mind assists in developing a comprehensive research literature, views of emotion developed primarily from observations of negative emotion as noted above and did not coherently explain the experience of positive emotions. An alternative view of positive emotions suggests that the ways that positive emotions differ from negative emotions allow them to serve protective functions against a variety of problematic outcomes. Fredrickson's Broaden-and-Build hypothesis (Fredrickson, 2001) suggests that the experience of positive emotion leads to exploration and development of physical, intellectual, and social resources, which are later available when under stress. Rather than the narrowing of focus and preparation for action that occurs with many negative emotions, positive emotions appear to broaden the scope of attention and planning, which over time leads to the building of durable resources. In Fredrickson's review of the empirical work that supports this theory, positive emotions were associated with numerous desirable outcomes including expanded attentional focus, heightened cognitive resources

(increased creativity, greater cognitive flexibility), increased variation in action-oriented approaches to problems, development of enduring social bonds, and enhanced learning and performance (Fredrickson, 2001). The view of positive emotion as protective suggests such emotions may serve both as a buffer from subsequent/upcoming negative emotional challenges and a protective factor during and following the course of such challenges. Further, this view suggests that those individuals who frequently experience positive emotions may show more adaptive responses in the face of emotion-based challenges.

Additional theories relevant to positivity

In addition to the Broaden-and-Build theory noted above, numerous other theories have been posited and tested that vary in how they conceptualize positive emotions as potentially serving either a buffering or tempering effect from negative emotion. Both pre-existing positive emotions as well as positivity that occurs during the course of or in response to a stimulus may be beneficial. For example, positive emotions present prior to the onset of a stressor may act as a buffer that completely prevents a stress response, or limits this response. In contrast, positive emotions experienced during stress may represent protective factors that similarly temper the response to and promote recovery from stress, but do not prevent a response from occurring altogether. Theories of positivity vary in how and when they conceptualize positive emotions as beneficial or not across numerous domains including psychological well-being, physiological response, social behavior and relationships, and mental and physical health.

One such theory is Zautra's Dynamic Model of Affect (DMA), which proposes that the relationship between positive and negative emotions changes during stressful experiences (Zautra, Reich, Davis, Nicolson, & Potter, 2000) due to increased demands elicited by the stressor that limit cognitive capacity. The model arose in reference to physical pain, but has since

been used to study a variety of challenges to psychological well-being (Smith and Hollinger, 2015). Specifically, this model suggests that during times of stress, positive and negative emotions are inversely related, such that an increase in positive emotions may decrease the amount of negative emotion experienced in response to a stressor.

In support of this theory, Moore and colleagues found that state anxiety and positive emotions were more strongly negatively correlated during a stress-inducing event, namely the Washington, DC sniper attacks (Moore et al., 2014). The correlation between these variables decreased following the conclusion of the stressful event. Similarly, a study of mothers of developmentally delayed adults found that under high levels of health-related stress, positive and negative affect were more strongly inversely correlated than during times of low health-related stress, when there was only a moderate correlation (Pruchno & Meeks, 2004). Most relevant to the current study, a stronger inverse relationship between positive and negative affect occurred during a laboratory stressor, relative to the correlation prior to and following the stressor (Zautra et al., 2000). According to the DMA, outside of a stressful situation, the individual has sufficient cognitive capacity to process greater affective complexity. In such contexts, positive and negative emotions should function independently (Zautra, Smith, Affleck, & Tennen, 2001).

Similarly, Lazarus, Kanner, & Folkman suggested that positive emotions may serve a protective effect from stress by allowing for the replenishment of resources depleted by stress and allowing greater opportunities for self-regulation (1980). In this way, the functional role of positive emotions during periods of stress is to provide a psychological "break" from stress, rather than preventing or limiting a response to stress. Support has emerged for this model in both experimental and applied settings (Moskowitz, Shmueli-Blumberg, Acree, & Folkman, 2012). In one laboratory study, Tice and colleagues found that individuals who experienced a

stress induction followed by a positive mood film induction persisted longer on a frustrating task than individuals who viewed a neutral film prior to presentation of the frustrating task (Tice, Baumeister, Shmueli, & Muraven, 2007). While the authors attributed this finding to the replenishment of psychological resources, the findings might be related to the physiological "undoing" effect of positive emotions proposed by Fredrickson and Levenson (1998), which return individuals to a baseline state.

In both Zautra's and Lazarus's models, those who frequently experience positivity during stressful times are perceived as less vulnerable to stress when compared to those with a relative deficit of positive emotions (Zautra et al., 2005). The Broaden-and-Build hypothesis described above suggests that positive emotions lead to the development of resiliency or resistance from stress for those who have an increased general tendency to experience positivity (Smith & Hollinger, 2015). In contrast, both the Dynamic Model of Affect and Lazaurus' theory about the adaptive role of positive emotions suggest that positive emotions experienced specifically during times of stress confer resiliency in the context of stress, but does not address the role of positive emotions outside of this context.

In contrast to the above theories that emphasize the valence of emotions, the Excitation Transfer theory places greater emphasis on emotional arousal (Zillman, 1972). Specifically, this theory posits that excitation occurring prior to the presentation of a stimulus, for example from a previous stimulus or physical activity such as exercise, may intensify or enhance an individual's response to the current stimulus. This is hypothesized to occur only when there is a possibility for the individual to misattribute their pre-elicited excitation to the current stimulus, rather than being enhanced by residual excitation from the previous stimulus. There has been some support of this theory in laboratory studies. For example, Cantor and colleagues used exercise to elicit

physiological arousal in a group of 45 male undergraduates (Cantor, Zillman, & Bryant, 1975). Participants' level of arousal was assessed both physiologically and subjectively using participants' ratings. In the next phase of the study, participants watched an erotic film during one of three post-exercise recovery phases. Those who watched the film during the period in which they subjectively believed their arousal had returned to baseline but continued to show physiological arousal reported being the most excited by the film relative to those participants who viewed the film immediately after exercising or after physiological activity had returned to baseline levels. Similarly, Meston and Frolich (2003) found that participants tended to rate photographs of opposite-sex individuals as more attractive and desirable just after a roller coaster ride as compared to those asked to rate the photographs prior to the roller coaster ride. Additional investigations of this theory have revealed heightened emotional responses to advertisements following a suspenseful sporting event (Bee & Madrigal, 2012) and higher sympathetic arousal when viewing advertisements following an arousing program relative to a calm program (Wang & Lang, 2012).

In relation to the current study, the Excitation Transfer theory might suggest outcomes in contrast to those proposed by the current study hypothesis, which propose that positive emotions serve to dampen physiological reactivity. In contrast, the excitation transfer theory suggests that those who experience higher levels of positivity prior to viewing the disgust-eliciting films would experience a physiological reaction that is enhanced relative to those lower in pre-film positivity. Additionally, the type of positivity experienced may be particularly relevant when considering how the excitation transfer theory may influence responding in the current study. While some positive emotions are associated with higher levels of physiological arousal, such as

excitement or excitation, other positive emotions such as calmness and happiness may not display the pattern of arousal necessary to generate excitation transfer.

Recent investigation into the contribution of positive emotions to health have sometimes focused on specific types of emotional experiences, rather than general positivity. For example, some have proposed that humor may serve as a buffer from stressful experiences (Labott & Martin, 1987). Martin and colleagues have extensively studied how humor may be beneficial to physical health, an idea with strong anecdotal support (Martin, 2002; Martin & Dobbin, 1988). Martin uses the term "coping humor" to describe a potential mechanism for the proposed beneficial relationship between humor and physical health, in that humor promotes an increase in individuals' ability to cope with stress (Martin & Lefcourt, 1983). Higher coping humor has been associated with greater psychosocial adjustment to stressors, such as childhood cancer (Dowling, Hockenberry, & Gregory, 2003), improvement in immune system functioning (Mahoney, Burrows, & Lippman, 2002), and better performance and fewer dysfunctional standards for self-evaluation on academic exams (Kuiper, Martin, & Olinger, 1993). Additional mechanisms include: increasing social support, triggering beneficial physiological processes, and finally, eliciting positive emotions that are associated with physiological undoing or increased longevity.

The last two mechanisms discussed (triggering beneficial physiological processes and eliciting positive emotions that undo the physiological effects of stress) may be relevant to the current study, although it is unlikely that the current study would serve to elicit the "hearty" laughter required to trigger the beneficial physiological processes proposed by Martin. Regarding the undoing mechanism noted by Martin, numerous studies have observed that induced laughter leads to better cardiovascular activity and reactivity opposing the pattern seen following a stressor (Miller & Fry, 2009; Vlachopoulos et al., 2009). Furthermore, these beneficial

physiological effects have been observed not just with laughter, but following amusement that occurred in the context of a stressor as well (Giuliani, McRae, & Gross, 2008). Notably, some individuals may respond to disgusting or disturbing images, such as those used in the current study, with amusement or laughter (Oppliger & Zillmann, 1997). If such displays serve to regulate physiological reactivity in a positive manner, this would provide further support for theories that suggest that positivity may contribute to decreased reactivity and better recovery.

In regards to trait positivity, it is also important to consider how dispositional optimism might influence reactivity and recovery to stress, given the moderate positive correlation of these variables (Boehm, Chen, Williams, Ryff, & Kubzansky, 2015). Optimism is defined in the literature as a generalized positive outcome expectancy (Scheier & Carver, 1985). While past research has demonstrated the ability to manipulate optimism (Hanssen, Peters, Vlaeyen, Meevissen, & Vancleef, 2012), it is generally considered a trait-like attribute that persists over time (Watson, 2000). Optimism has been associated with numerous adaptive outcomes (Carver, Scheier, & Segerstrom, 2010), including reduced pain (Hanssen et al., 2012), reduced risk of coronary heart disease (Kubzansky, Sparrow, Vokonas, & Kawachi, 2001), and faster recovery from surgery (Scheier, et al., 1989). Optimism has also been associated with important physiological outcomes related to reactivity and recovery from stress. Higher levels of optimism were related to faster cortisol recovery after exposure to a stressful task in older adults (Puig-Perez, et al., 2015), while pessimism showed no relationship with the speed of physiological recovery. Further investigation of optimism may help us better understand the distinct role of positive outcome expectancies in response and recovery to emotional challenges as compared to the role of a tendency to experience positive emotions.

Thus, positive emotions have been characterized as functioning in a number of ways that may vary based on factors such as context, prior emotional state, and personality traits. One theme that is apparent from the review of these theories is that they address the beneficial aspects of positive emotions, and do not explicitly make predictions or even include consideration of instances when positive emotions may be problematic. This is likely for two reasons: one, that overall, the literature suggests that in most cases, positive emotions are related to beneficial outcomes, and that problematic outcomes may be present only for particular groups, such as those who experience mania, people with asthma experiencing high arousal positive emotions that may induce asthma attacks, and elderly individuals whose positivity prevents them from seeking medical care. Our knowledge about the extent to which positivity can lead to negative outcomes may not be advanced enough to the point that these nuances are reflected in these theories.

A second reason that the current theories on positive emotions emphasize beneficial outcomes may be that manner in which we think and feel about positive emotions in general is reflected in these theories. Thus, the theories above, which universally originated in Western contexts, may be a reflection of social beliefs. The literature on emotion norms supports this notion, in that within cultures where positive emotions are viewed as potentially problematic (i.e. in Eastern contexts where display of individualistically-based positive emotions are sometimes viewed as a threat to interpersonal harmony), emotion norms reflect this more mixed perspective on positive emotions. At the present time, these beliefs do not appear to have emerged through the literature as emotion theories, but whether cultures where emotions are viewed differently hold different theories or hypotheses about the impact of emotions nevertheless remains an interesting question.

The present study is based primarily on Fredrickson's Broaden-and-Build hypothesis, which predicts that those who tend to experience positive emotions come to develop resilience and resources that allow them to better tolerate and recover from later challenges. Trait positivity and state positive emotions are assessed in this study prior to viewing study stimuli, and are predicted to limit reactivity to study stimuli and be associated with better recovery. Facial expressions of positivity are also included as a measure of positive emotions, which could be viewed as inconsistent with the Broaden-and-Build theory, but are included in this study as a reflection of individuals' tendency to experience positive emotions.

Regarding the additional theories above, Zautra's Dynamic Model of Affect could also be viewed as relevant to behavioral positivity in this study. This model would suggest an inverse relationship between expressions of positive emotions versus negative emotions. As noted above, the Excitation Transfer Theory is not likely to be relevant to the current study due to the timing of study components. We measure physiological outcomes during and directly after termination of the stimuli, which likely does not allow for reduction of physiological activation to the extent that this activation might be misattributed to another source. Theories surrounding humor may be relevant to this study in that some individuals respond to disgust with laughter or amusement, but aside from this, the study does not include stimuli designed to elicit humor. Thus, the experience of humor in this study would likely reflect individual variation in coping methods, rather than a product of the study design that would allow for a controlled study of humor responses. Therefore, while the current study is based primarily on the Broaden-and-Build theory, some of the theories above may be important to consider if the results of the study are not consistent with our hypotheses.

Positive emotions, reactivity, and recovery

The next section will review research conducted in laboratory settings, which is most relevant to the current study. While the above literature has utilized primarily prospective, correlational, or longitudinal measures outside of the laboratory setting to observe the impact of positive affect on physical health and physiological consequences, experimental studies that occur in a laboratory setting can allow for more precise understanding of the ways that the experience of positive emotion is associated with shorter term physiological and behavioral changes (Chida & Hamer, 2008).

Historically, much of this research has focused on measures of reactivity, or the magnitude of responses to positive or negative stimuli. Recovery, in contrast, has been relatively understudied in the stress and disease literature (Linden et al., 1997). However, there are conceptually important reasons for investigating recovery in addition to reactivity given that over the long term, recovery may have a greater contribution to detrimental patterns of physiological responses and associated health outcomes than reactivity (Tugade & Fredrickson, 2004). Thus, it seems important to consider both of these variables when studying adaptive and maladaptive responses to negative stimuli. As noted above, positive emotions may serve as a buffer and protective factor from the effects of negative stimuli (Pressman & Cohen, 2005). Research investigating the ways positive emotions influence reactivity and recovery, as well as investigating its role as protective from negative emotion, is reviewed below. In this section, I first review studies that investigate the influence of positive emotion induced following a negative stimulus or in preparation for a negative stimulus. I then discuss studies that observe the influence of naturally occurring positive emotions as a buffer prior to the presentation of a negative stimulus or challenge.

Positive affective behavior in response to negative stimuli

Regarding physiological reactivity, research has provided mixed support for the notion of positive emotions as beneficial. A meta-analysis conducted by Chida and Hamer (2008) investigated how positive psychological states and traits related to chronic psychosocial factors and physiological responses to stress. In this group of studies, positive psychological states and traits included concepts such as happiness and positive mood, and related concepts such as self-esteem, empathy, effectiveness of emotion regulation, and coping. They found that positive psychological states and traits were often associated with more adaptive physiological responses, defined as reduced HPA reactivity. Positive psychological states and traits appeared beneficial in preventing the release of hormones (i.e. cortisol) associated with HPA reactivity. However, as noted above, the pattern of results indicates that the level of arousal associated with these emotions is important to consider. Those positive emotions that activate a relatively higher level of arousal, such as happiness, joy, and excitement, have been associated with increased reactivity within laboratory settings, including increased heart rate and blood pressure (Ekman, Levenson, & Friesen, 1983; Futterman, Kemeny, Shapiro, & Fahey, 1994; Knapp et al., 1992). However, such reactivity is not to the extent of highly activating negative emotions such as anger. While positive emotions do not typically reach this level of intensity in naturalistic settings, during times that high arousal positive emotions are highly activated, they may be accompanied by changes in physiological activity that can be damaging over the long term or can elicit immediate detrimental health problems (i.e. asthma attacks). In contrast, lower arousal positive emotions appear to influence reactivity primarily when following negative emotions, and serve to dampen arousal associated with such emotions, supporting a model of positive emotions as protective (Levenson, 2000). While the above discussion of reactivity suggests that highly arousing positive

emotions may trigger harmful physiological processes, this view overlooks many of the non-physiological benefits associated with such emotions, such as promoting social relationships (Oatley & Jenkins, 1992). Moreover, even higher arousal positive emotions have at times been associated with dampened physiological response. For example, an investigation of the effects of positive affect on pain sensitivity in men found that pain sensitivity diminished after viewing a film depicting a couple's romantic involvement and physical intimacy (Zillman, de Wied, King-Jablonski, and Jenzowsky, 1996).

In addition to studies of reactivity, there has recently been some investigation of whether positive emotions promote faster physiological recovery. The undoing hypothesis proposes that certain positive emotions may lead to more rapid recovery from the cardiovascular sequelae of negative emotions (Fredrickson & Levenson, 1998). This theory does not suggest that the experience of positive emotions results in a calm or resting state, but rather that those who experience positive emotions will more quickly return to a state of baseline autonomic activity (characterized by mid-range levels of activation). Restoration of a baseline state can reduce our experience of tension and arousal, and thereby increase our ability to engage in problem-solving behaviors (Yuan, McCarthy, Holley, & Levenson, 2010).

In two studies, Fredrickson and Levenson provide support for the undoing hypothesis. In Study 1, subjects initially viewed a fear-eliciting film (depicting a man standing on a ledge). Participants then viewed one of four secondary films that had previously been demonstrated to induce contentment, amusement, neutrality, or sadness (Gross & Levenson, 1995). Those participants who viewed one of the two positive films (amusement or contentment) exhibited a more rapid return to pre-films levels of physiological activation than those who viewed the neutral or sad films. Study 2 investigated whether spontaneous displays of positive affect,

conceptualized as the number of times participants smiled while viewing a sad film, was associated with cardiovascular recovery. Results indicated that subjects who smiled at least once displayed a quicker return to baseline physiological activation. However, it is unclear if these findings were due to a direct effect of smiling, in that the act of smiling may have affected physiological responses (Buck, 1980), or to some other mediating factor (i.e. higher trait optimism) that makes individuals more likely to respond with positivity to a negative stimulus.

In a follow-up to the above work, Fredrickson and colleagues conducted two additional studies to address limitations to the original studies (Fredrickson, Mancuso, Branigan, & Tugade, 2000). Study 1 modified the original fear-eliciting stimulus to one that was considered to be more personally salient and required participants to actively engage with the stimulus. Participants were instructed to prepare a speech and then viewed one of four films known to elicit contentment, amusement, neutrality, or sadness. Again, those who viewed the contentment and amusement films exhibited faster physiological recovery, providing further support for the undoing hypothesis. Study 2 replaced the fear-eliciting film with a neutral film to test whether the effect of positive emotions might be due to a replacement effect. However, there was little effect of the positive films on physiological measures following a neutral stimulus, in the absence of reactivity to negative stimuli. This provides support for the undoing hypothesis, in that positive emotions appear to be beneficial as a way of regulating reactivity to negative emotions, but do not appear to provide significant benefits in the absence of such experiences.

Relatedly, another study investigated how positive emotions contributed to the effect of instructed task appraisal in low and high resilient participants (Tugade and Fredrickson, 2004) and also observed how these factors were related to physiological recovery. Results indicated that for those instructed to appraise the task as a challenge, there were no differences in recovery

time between participants high and low in resilience. Furthermore, those who were instructed to appraise the task as a challenge displayed faster physiological recovery relative to those who appraised the task as a threat, and these findings were mediated by positive emotion experience. The authors concluded that positive emotions guide coping behavior, providing further support for Fredrickson's Broaden-and-Build theory, and that this contributes to physiological recovery. The facilitation of cardiovascular recovery that occurs via positive emotions leads to broader patterns of thoughts and actions, which then promote exploration of emotion regulation approaches (Fredrickson, 2000). Highly resilient individuals appear to experience positive emotions even during times of stress, and these self-generated positive emotions lead to more rapid recovery.

In addition to physiological responses, cognitive, behavioral and affective responses are also important when considering how positive emotions may contribute to response and recovery from negative stimuli. In addition to aiding physiological recovery, such emotions appear to also contribute to amelioration of the cognitive effects of negative emotions (Falkenstern, Schiffrin, Nelson, Ford, & Keyser, 2009). In one study of 86 college students, participants who were induced into a positive mood state via film clips showed better cognitive processing in a letter identification task as compared to those who viewed neutral or negative clips. Thus, measurement of cognitive responding in addition to physiological responding may be helpful in further demonstrating the potential undoing effects of positive emotions. Measurement of behavioral responses also provides access to aspects of the individual's emotional experience that may be outside of subjective experience (Lucas, Diener, & Larsen, 2009). The characteristic behavioral response to disgust, the negative stimuli in the current study, includes raising of the upper lip and wrinkling of the nose associated with the levator labii muscle. However, some

individuals appear to spontaneously display positive emotions, such as smiling, in response to disgusting stimuli. Spontaneous smiling has been associated with greater distress during the presentation of disgust stimuli, but with more positive affect after the termination of the stimuli (Ansfield, 2007). This indicates that smiling while distressed may serve a self-regulatory function in response to disgust. Of note, men appear to smile more than women when viewing disgusting segments, despite evidence that women generally smile more frequently than men. Such gender effects are likely to be attributable to cultural display rules dictating that men should suppress the expression of negative emotion, relative to women, and may also reflect avoidance behaviors given the strong visceral response to disgust and urge to expel associated with this emotion. Finally, regarding subjective responses, disgust is associated with higher arousal ratings and lower valence ratings, when compared to other negative emotions (Stark, Walter, Schienle, & Vaitl, 2005).

Self-reported positive affect as a buffer

Thus, there is some evidence that positive emotion during or following a negative stimulus can be beneficial to recovery. However, another possibility suggested by the Broaden-and-Build theory is that the experience of positive emotions *prior* to a negative stimulus can serve as a buffer from negative emotions. Similar to the stress-buffering hypothesis, which proposes that social support protects individuals from the negative outcomes associated with stress (Cassel, 1976), the experience of positive emotion prior to the experience of negative emotions may be similarly protective. In unpublished data, Fredrickson & Mancuso (1996) modified the above studies to test for a buffering or protective effect of positive emotions. In this study, participants first viewed a film that elicited either contentment, amusement, sadness, or no emotion, followed by a fear-eliciting film. There were no significant differences in recovery

among the groups, and thus, no evidence emerged of a buffering effect for those who were induced to feel positive emotions by viewing the contentment or amusement film. The authors argue that negative emotions interrupt affect and narrow attention, and that this appears to occur regardless of prior affective state. However, they hypothesize that positive affect may instead serve as a buffer over time by bolstering coping resources and building resilience.

Although the above study suggests that *induced* positive affect may not have a protective effect from negative emotion, it does not address whether *spontaneously occurring* state affect or trait positive affect serves this function. The effects of naturally occurring positive emotion may have a greater impact and be more enduring in terms of response to or recovery from negative stimuli, relative to induced positive affect. Furthermore, spontaneous positive emotion is more likely to reflect a general means of responding in potentially adaptive ways to negative stimuli or experiences. Evidence from studies of naturally occurring positive emotion that show more rapid recovery would be consistent with literature supporting the beneficial impact of positive affect on physiological and long-term health outcomes (Pressman & Cohen, 2005). Papousek and colleagues (2010) conducted a study of naturally occurring state positive affect to examine whether experiencing positive affect prior to a challenge is protective. State positive affect was measured using a standardized 17-point rating scale assessing current levels of joy. Results for state affect did not support the hypothesis, and instead showed that positive affect prior to exposure to academic stress was associated with poorer post-stress recovery in terms of heart rate, heart rate variability, and blood pressure. However, state affect in this study was measured *after* participants were informed about the stressful stimulus, and thus the affect measured may have reflected an initial response to the challenge rather than an existing positive state at the outset of the experiment. Furthermore, the emotion measured, joy, reflects a high-arousal

positive emotion and has previously been associated with increases rather than decreases in physiological reactivity. Therefore, experiencing higher levels of joy may hinder rather than promote recovery. Additionally, the authors hypothesized that the nature of the task may have elicited surprise in more positively-valenced individuals relative to less positive individuals, further increasing their levels of arousal. However, they found that trait positive affect measured via the PANAS (which assesses moderately to highly arousing positive emotions in addition to a range of negative emotions), was associated with more complete cardiovascular and subjective recovery. Those reporting higher trait positive affect showed faster recovery in parasympathetically-dominated heart rate variability.

A similar study investigated how the experience of state positive emotions prior to an emotion-based challenge is related to recovery in individuals with varying levels of resilience (Tugade & Fredrickson, 2004). In this study, participants provided self-report data regarding current levels of positive and negative emotion (measured via a modified PANAS scale) prior to an anxiety-provoking task instructing them to prepare for a speech. They also provided ratings of 14 emotions during the experiment while their physiological responses were also recorded (heart rate, finger pulse amplitude, pulse transmission time to finger and ear, and diastolic and systolic blood pressure). They were then instructed to mentally prepare for the speech. Higher levels of positive emotion *prior* to the task were associated with more rapid recovery, in contrast to the above studies that failed to uncover a protective effect of state positive emotion in response to a challenging task.

Therefore, there is conflicting evidence regarding the buffering impact of positive emotion prior to exposure to negative stimuli. One reason for this may be the variability in the types of paradigms utilized in the above studies. While the above studies used primarily fear or

anxiety-inducing stimuli, the use of other negative emotions has been limited. The nature of some of these less-studied emotions and their potentially different ways of impacting physiological responses may clarify the ways that positive emotions provide a buffering effect from negative emotions. For example, disgust may elicit a more visceral and less cognitively-based response relative to other negative emotions, and thus rely more heavily on physiologically-based coping such as down-regulation of arousal, relative to other negative emotions. Additionally, in the studies that failed to uncover a buffering effect of positive emotion prior to a negative stimulus, aspects of the experimental designs make the findings difficult to interpret. For example, in Fredrickson and Mancuso's study (1996), the use of induced positive emotion rather than naturally occurring emotion may not adequately capture tendencies to generate positive emotion in response to challenges. Additionally, the type of negative stimuli used by Papousek and colleagues, which appeared to cause surprise in addition to the target negative emotion, led to increased physiological arousal (Papousek et al., 2010), which may have hindered recovery that would have occurred solely in response to the negative emotion.

The physiological responses associated with negative emotion may shed light onto the failure of the above studies to consistently reveal a buffering effect of positive emotions. As noted above, disgust shows a different pattern of responses than the negative emotions of fear and anger, which have been most frequently investigated in emotion regulation research and specifically in the recovery research. While these more frequently studied emotions exert an effect primarily in the sympathetic domain, disgust has also been associated with activation of the parasympathetic domain. Because it remains unclear whether positive emotions aid recovery by dampening sympathetic nervous system activity or by activating parasympathetic nervous system (PNS) activity, disgust may be the most suited negative emotion to observe influences of

positive emotions that may be associated with PNS activation. Activity of the PNS on cardiovascular activity has sometimes been referred to as the vagal brake due to the resulting decrease in cardiovascular reactivity that occurs via the vagus nerve (Soto & Minnick, 2017). If positive emotions increase the activity of an already activated PNS system, positive emotions may serve to more quickly achieve recovery following a disgust response.

In regard to its function, disgust is associated with the urge to expel and serves to protect individuals from real or perceived contamination (Olatunji & Sawchuk, 2005; Rozin & Fallon, 1987). Heart rate, skin conductance, and muscle activity are the most frequently studied physiological responses to disgust (Stark et al., 2005). Notably, disgust produces a deceleration in heart rate, in contrast to the acceleration typically seen for other negative emotions (Cisler, Olatunji, & Lohr, 2009; Kreibig, Wilhelm, Roth, & Gross, 2007; Gilchrist, Vrinceanu, Beland, Bacon, & Ditto, 2016). In comparison to neutral pictures, disgust-inducing pictures produce significantly lower peak accelerations (Lang, Greenwald, Bradley, & Hamm, 1993), and heart rate further decelerates as the intensity of disgust stimuli increases (medium to highly-disgust inducing; Stark et al., 2005). As addressed above, this deceleration has been theorized to reflect parasympathetic activation in response to disgust, although sympathetic activation in response to disgust has been observed as well (Rohrmann & Hopp, 2008). Recovery from disgust is likely to look different from recovery from previously studied negative emotions, in that it would reflect an increase in heart rate to return to baseline levels of activation. Investigation of this emotion may provide additional information regarding the ways in which we manage emotion-based challenges. In regard to other physiological indices, disgust has also been observed to produce less decrease in finger temperature, relative to sadness (Levenson, Cartensen, Friesen, & Ekman, 1991). In terms of skin conductance, disgust appears to produce an initial orienting response

followed by habituation. However, in one study, some individuals did not show a response for skin conductance measures in response to medium to highly-disgust inducing pictures displayed for 8 seconds (Stark et al., 2005).

Cultural norms and positive emotion

The findings above regarding the influence of gender norms surrounding emotion (Ansfield, 2007) suggest that related cultural norms may also influence responses to disgust and highlights the need to consider how such norms may also impact the buffering role of positive emotions in response to negative stimuli. Culture is highly influential in determining how emotions are processed and regulated (Markus and Kitayama, 1994). Expectations regarding the optimal experience and expression of both positive and negative emotions are transmitted though cultural scripts, or narratives that correspond to different values placed on emotions (Miyamoto and Ma, 2011). It is important to consider such cultural differences surrounding positive emotions because previous research in the area of positive emotions and physiological and behavioral outcomes has been conducted with primarily Caucasian participants. Thus, the extant research literature may not reflect possible cultural variations in how the experience of positive affect influences subsequent responding to negativity (Pressman, Gallagher, Lopez, & Campos, 2014). While Western cultural norms place value on the experience and open expression of both positive and negative emotion, many Eastern cultures value moderation in positive and negative emotions in order to maintain interpersonal harmony.

The influence of such norms is reflected in prior research that shows variations in the manner in which individuals from differing cultures regulate emotions. For example, individuals from Eastern cultures appear to dampen or down-regulate their positive emotions while individuals from Western cultures are more likely to engage in hedonic emotion regulation, or

savoring (up-regulating and maintaining) their positive emotions (Miyamoto, Uchida, & Ellsworth, 2010). Additionally, Easterners are more likely to value the experience of dialectical emotions, or co-occurring positive and negative emotions (Sims et al., 2015). Thus, relative to those who ascribe to Western norms, Easterners appear to more frequently generate emotions that oppose the dominant affect in a given situation. It may be that individuals from cultures that more highly value the balance of positive and negative emotions or the experience of dialectical emotions demonstrate a tendency to respond with both positive and negative emotions to a challenging task. Individuals who can flexibly experience both positive and negative emotions appear to experience a buffering effect from negative experiences and subsequent onset of psychological symptoms (Fredrickson, Tugade, Waugh, & Larkin, 2003), and thus this buffering effect may be experienced more frequently in individuals from cultures that emphasize balanced or co-occurring positive and negative emotions. In the current study, as compared to Westerners, Easterners may be better able to spontaneously generate positive emotions in order to balance the negative emotions likely to be elicited by the disgust stimulus. The physiological benefit of such positive emotions would contribute to the proposed buffering effect of state positive emotion.

While Latino cultures are similar to Asian cultures in their emphasis on collectivism, there are variations in the extent to which the norms for these cultures emphasize positive emotions. For example, the concept of Simpatía reflects the high value Latino cultures place on the experience and expression of positive emotions in order to maintain interpersonal harmony (Triandis, Marin, Lisansky, & Betancourt, 1984; Holloway, Waldrip, & Ickes, 2009). Negative emotions are perceived as disruptive to interpersonal relationships and thus their expression is discouraged. The extent to which these cultures promote and value certain emotions is important because it appears to influence the actual emotional experience of individuals from these cultures

(Sims et al., 2015), as demonstrated in numerous empirical studies. Soto and colleagues (Soto, Levenson, & Ebling, 2005) found that Mexican participants reported experiencing more positive emotion in response to an anticipated startle in a laboratory setting and reported more positive and negative emotions overall as compared to Chinese participants. If positive emotion serves as a buffer from negative stimuli, the findings from this study suggest that individuals from Latino cultures may more frequently experience this buffer effect due to a response style characterized by positivity. It may also be that the emotion norms for Latinos provide a benefit to this group by leading them to more easily generate positive emotions even when faced with negative events or stimuli.

Thus, as a result of emotion norms surrounding positive emotions, both Asian and Latino cultures may experience a superior buffering effect due to positivity that serves a protective benefit when faced with negative stimuli, relative to Caucasians. Although there is variation in the norms for these groups, it is possible that both norms promote the generation of positive emotions that may serve as a buffer from the experience of negative emotions: Asians by adding positivity to balance a negative situation and Latinos by attempting to replace negativity with positivity. Thus, both groups may show a stronger relationship between positive emotions and a buffering effect relative to Caucasians, but in a different manner for each group. Due to their emphasis on positivity, both trait and state positive emotions are likely to assist Latinos in their response to negative emotions, while for Asians, those who spontaneously generate positive emotion in the absence of positive stimuli may experience more adaptive outcomes. Thus, emotion norms may lead to differences among cultural groups that are associated with improved cardiovascular recovery. I will test this theory in the present study.

While this study also includes an African-American sample, cultural norms for African-Americans are not readily available in the extant literature. Thus, the study does not include specific hypotheses regarding how African-American participants are anticipated to respond to or recover from the study tasks. However, because this group experiences elevated rates of cardiovascular disease and the highest rates of deaths related to cardiovascular problems (Go et al., 2014), observation and understanding of physiological responses relevant to cardiac outcomes may be particularly important for this cultural group.

The present study

In the current study, I investigate the role of state and trait positive emotions in reactivity and recovery from negative stimuli designed to elicit disgust. I expect both state and trait positive emotions to serve either a protective or buffering role, and to be associated with better recovery to a baseline state of physiological arousal. Better recovery is defined as levels of mean reactivity that approach baseline values during the two minutes following presentation of the stimulus. I also expect positive emotion during presentation of the stimuli, conceptualized as facial cues associated with positive emotion, to be associated with better physiological recovery, higher subjective ratings of positive emotions following the stimuli and lower subjective ratings of negative emotions following the stimuli.

The current study builds on past research that has investigated reactions to disgust-inducing stimuli. However, this study is unique in its focus on the role of positive emotions in recovery from disgust, a negative emotion that has not been addressed in relation to physiological recovery and positive emotions. Further, the current study combines physiological, behavioral, and self-reported measures to allow for a thorough and nuanced understanding of the response to disgust and how this is influenced by trait and state positive emotions. Both state and

trait measures of positive emotions are included in the study, providing information regarding how tendencies to experience positive emotions as well as the how the momentary experience of positive emotions contributes to responding. Trait positivity will be represented using scores from two measures completed prior to the start of the experiment, while state positivity will include multiple facets of spontaneous emotional experience, including state emotion ratings at multiple instances during the study and behavioral measures of positive emotion collected during exposure to both neutral and disgust-inducing stimuli. Inclusion of these varied types of positive emotion will allow for a more nuanced understanding of the contribution of positive emotion to reactivity and recovery from negative emotions.

Finally, given the varying emotion norms surrounding positive emotions for the cultural groups included in this study, I predict a moderation by culture of the importance of positive emotion in response to negative stimuli presented in this study. I will observe whether the experience of positive emotions is associated with improved outcomes for Latinos, given their high value of positive emotion which may lead individuals from this group to more frequently experience positive emotions both generally, in response to non-positive stimuli, and spontaneously. Similarly, given the greater tendency in Asian cultures toward dialectical thinking and the simultaneous experience of positive and negative emotions, this group may be more likely to generate positive emotions in order to balance the negative emotions elicited by the study stimuli, and thereby make them more likely to experience a buffering effect that arises from the experience of positive emotions. Additionally, given that membership in some cultural groups (i.e. African-American) is associated with higher rates of cardiovascular stress (Centers for Disease Control and Prevention, 2009; Williams & Jackson, 2005), further illumination of the

role of positivity in cardiovascular reactivity and recovery may help identify resilience to stress in these groups as well as possibly inform the development of adaptive coping strategies.

Hypotheses

Hypothesis 1: Those with higher baseline levels of state positive emotion prior to a disgust-inducing stimulus, relative to those with lower levels of baseline state positive emotion (defined as a higher aggregate score of positive emotion ratings prior to the first film) will show less physiological reactivity and better recovery to pre-film baseline levels of physiological activity. Reactivity is defined as change in physiological arousal from pre-film baseline to arousal during the disgust film. Recovery is defined as change in physiological arousal from disgust film to the post-film rest period.

Hypothesis 2: Additionally, those with higher levels of trait positive emotion prior to a disgust-inducing stimulus, as indicated by scores on the Center for Epidemiologic Studies – Depression scale (CES-D) positive affect subscale and Satisfaction with Life Scale (SWLS) measure, will show less physiological reactivity and better recovery to pre-film baseline levels of physiological activity.

Hypothesis 3: Those who display more facial expressions of positive emotion during the neutral film will show better physiological recovery after the disgust film. Similarly, those who display more facial expressions of positive emotion during the disgust inducing film will show better recovery.

Cultural Moderation Hypotheses: Because of emotion norms emphasizing positivity, I expect a moderation by culture of the above effects such that there will be a stronger association between trait positivity (using the CES-D positive affect subscale) as well as facial expressions of positive emotions during the disgust film and physiological recovery for Latinos, relative to

other ethnic groups. For Asians, I expect a similar relationship between facial expressions of positive emotions (i.e. naturally occurring facial expressions associated with positivity) and physiological recovery.

Chapter 2
METHOD

Participants

A sample of 210 participants was recruited from introductory psychology classes at a large university in the Northeastern U.S. and from the campus community. Participants enrolled in the study for course credit or $18 compensation. Individuals were invited to participate in the study if they met inclusion criteria related to their ethnic background and were between 18 and 40 years old. A demographic screener survey was used to determine participant eligibility, including ethnic criteria (see below). Similar to the criteria employed in other studies of culture and psychophysiology (see Soto et al., 2005 and Soto & Levenson, 2009), we relied on several pieces of culturally-relevant information, including behavioral information, to go beyond racial or ethnic self-identification to characterize our groups. The final sample included 38 Latinos (18%), 52 Asian Americans (25%), 45 African Americans (21%), and 75 European Americans (36%). The age range of the sample was between 18 and 34 years and the mean age was 19.67.

Eligibility Criteria. European Americans must have been born and raised in the U.S. and had to self-identify as White or European American. Participants' parents and grandparents also had to report being born in the U.S. and identify as White or European American (for a more in-depth discussion of these cultural criteria see Soto et al., 2005). In addition, European American participants had to report being of Christian or Catholic religion, or growing up with these religions being practiced in their households. Finally, participants had to report that over fifty percent of their friends while growing up and over forty percent of their neighborhood while growing up were of European American background.

Asian American participants had to self-report their ethnicity as Asian or East Asian (e.g., Chinese, Korean, Japanese, and Vietnamese) and have been born either in an East Asian country

or in the United States. South Asian participants from countries such as India, Pakistan or Bangladesh were not eligible. In addition, both participants' parents and grandparents also had to meet the same birth country requirements. Furthermore, participants had to be conversant, though not fluent, in both English and in the Asian language of their culture of origin. There were no religious criteria for the Asian American participants. The criteria around childhood friends and neighborhood were also not applied to this group because immigrant populations may have limited choice as to where they geographically settle and therefore this may have been an unrealistic standard for the Asian American participants in the community from which participants were sampled.

Latino participants had to self-report their ethnicity as Latino (e.g., Mexican, Cuban, Central American, Puerto Rican, etc.) and have been born either in a Latin American country or in the United States. In addition, participants' parents and grandparents had to have been born in a Latin American country and identified as Latino (though which specific group was not important). Furthermore, participants had to be conversant, though not fluent, in both English and Spanish and report that they were Catholic or Christian or grew up in either religious tradition. Latino participants had to report that over fifty percent of their friends while growing up and over ten percent of their neighborhood while growing up were of the same ethnicity.

Finally, African American participants had to have been born and raised in the U.S. and had to self-identify as African American. Participants' parents and grandparents also had to report being born in the U.S. and identify as African American (for a more in-depth discussion of these cultural criteria see Soto et al., 2005). There were no stated criteria regarding religious affiliation for this group. In addition, African American participants had to report that over fifty

percent of their friends while growing up and over ten percent of their neighborhood while growing up were of the same ethnicity.

Apparatus

Upon arrival in the lab room, participants met with a research assistant who obtained consent and answered any questions about the experiment. Participants were seated in a comfortable chair 3 feet away from a 19" LCD monitor, which was connected to a computer using E-prime software to gather self-report responses to baseline questionnaires and emotion ratings. Experiment instructions and stimuli were also presented on this screen (see Procedures section). Participants were video-recorded using a remotely controlled video camera. Experimenters were able to communicate with and monitor participants from a control room next door equipped with an audio and video system.

Self-Report Measures

Center for Epidemiologic Studies – Depression scale (CES-D). Participants completed this measure consisting of 20 items corresponding to depressive symptomatology. The scale asks respondents, "How often in the last week did you feel this way?" Answers are provided using a 4-point scale: 0 = *rarely or none of the time (< 1 day)*, 1= *some or a little of the time (1–2 days)*, 2 = *a moderate amount of the time (3–4 days)*, or 3 = *most of the time (5–7 days)*. This measure has demonstrated very good internal consistency, acceptable test-retest stability, evidence of construct validity, and good concurrent validity as assessed by clinical and self-report criteria (Radloff, 1977; Weissman, Sholomskas, Pottenger, Prusoff, & Locke, 1977). For the present study, I primarily make use of the positive affect score, which has been used in previous research investigating the relation between affect and physiology (Ostir, Bergeman, Bisconti, & Wallace, 2000; Ostir, Markides, Peek, & Goodwin, 2001; Moskowitz, 2003). Factor analyses have

consistently found that four items load onto a single Positive Affect factor (Miller, Markides, & Black, 1997; Radloff, 1997; Roberts, 1980; Sheehan, Fifield, Reisine, & Tennen, 1995). These include: “I felt that I was just as good as other people,” “I felt hopeful about the future,” “I was happy,” and “I enjoyed life”. Participants were asked to recall the past week when responding to these items. Scores for Positive Affect (PA) will therefore be used as an approximation of trait PA. A Cronbach’s alpha of .81 indicated that the positive affect subscale exhibited good reliability in the present sample.

Satisfaction with Life Scale (SWLS). The Satisfaction With Life Scale (Diener, Emmons, Larsen, & Griffin, 1985) is a measure of psychological well-being. It consists of 5 items rated using a 7-point, Likert type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), which are summed to create a single global factor of life satisfaction. Prior studies utilizing this measure have established reliability and validity of the SWLS (see Diener et al., 1985). Measures of cognitive well-being such as the SWLS display moderate (Lucas, Diener, & Suh, 1996) to strong (Watson & Naragon, 2011) correlations with the experience of positive emotions. In addition to the CES-D Positive Affect subscale, the SWLS will provide a secondary measure of trait positivity. A Cronbach’s alpha of .85 in this sample indicated the scale exhibited good reliability.

Emotion ratings. Participants rated their emotion levels during a baseline assessment period and following each film’s recovery period using a 9-point Likert type scale (0 = *none* and 8 = *very much*). Participants rated their current experience of the following 16 emotions: amusement, anger, annoyance, anxiety, boredom, contempt, contentment, disgust, embarrassment, fear, happiness, interest, relief, sadness, stress, and surprise. A mean aggregate score for positive emotion will be created using ratings for the following items: amusement, contentment, happiness, and interest. Emotion ratings for positive items provided at baseline prior to viewing

the neutral film will be used as a measure of naturally occurring state positive affect prior to any study manipulation.

Psychophysiological Measures

Electrocardiography (EKG) and skin conductance level (SCL) were recorded using a Mindware impedance cardiograph (MW2000) in conjunction with the Biopac© MP150 device consisting of an eight-channel polygraph and a microcomputer. All physiological data was collected second-by-second using AcqKnowledge© software to be analyzed using Mindware© software. EKG, which provides a measure of cardiac activity, was measured through three Biopac pre-gelled, self-adhering, disposable electrodes placed at three places on the torso: the right clavicle at the midclavicular line, just above the last bone of the ribcage at the left midaxillary line, and just below the last bone of the ribcage at the right midaxillary line. From the EKG signals, we can derive the interbeat interval (IBI). IBI is calculated as the elapsed time in milliseconds (ms) between heart beats and is the inverse of heart rate (HR). Thus, higher interbeat intervals are indicative of slower heart rate or lower physiological arousal. Given the inverse relationship of IBI and HR, only results for HR will be presented for this study.

Indicators of both sympathetic (SNS) and parasympathetic nervous system (PNS) arousal can be obtained from analysis of cardiac data. Impedance cardiography is a method of collecting cardiovascular functioning data that can provide a more accurate delineation of pure sympathetic versus parasympathetic activity in the autonomic nervous system (Berntson, Cacioppo, & Quigley, 1994). SNS indices include cardiac output (CO), stroke volume (SV), left ventricular ejection time (LVET), and pre-ejection period (PEP). CO is a measure of the overall volume of blood being pumped by the heart. SV represents the volume of blood ejected by the left ventricle of the heart in one beat, and is calculated by subtracting the volume of blood in the heart after

ejection through the aorta (afterload) from the amount of blood in the heart before ejection (preload). LVET is a measure of myocardial contractility and is equivalent to the amount of time, in milliseconds between the opening and closing of the aortic valve or mechanical systole (Brownley, Hurwitz, & Schneiderman, 2000). Finally, PEP is an indicator of sympathetic myocardial drive and indicates the interval between onset of the EKG Q-wave and onset of the left ventricular ejection. In contrast to CO, SV, and LVET, which increase with sympathetic activity, PEP decreases as SNS activity increases.

Finally, respiratory sinus arrhythmia (RSA) is also derived from the impedance cardiography and provides information regarding the natural variation in heart rate that occurs between inspiration and expiration in the breathing cycle and can be used as an indicator of PNS activity (Berntson et al., 1994). RSA has shown numerous associations with positive moods and positivity, and thus may be an especially important biological indicator when examining state positive emotions and health-related processes. For example, resting RSA has been associated with positive tonic emotionality (enduring positive mood) and dispositional optimism in a sample of university students followed over 8 months (Oveis et al., 2009). Similarly, Wang and colleagues found that baseline RSA was associated with trait positivity, but not trait negativity (Wang, Wei, & Rongcai, 2013).

SCL, or skin conductance level, provides an index of sweat gland activity at the surface of the skin in microsiemens (μS). This index was measured using two reusable electrodes filled with isotonic recording gel that were placed on the middle phalange of the first and third fingers of the non-dominant hand, and secured with Velcro straps and medical tape. Increased stress responses and an orienting response to new stimuli are indicated by higher levels of SCL. In

addition, to SCL, the current study will examine how the following variables are associated with positivity: HR, RSA, PEP, LVET, CO, and SV.

Emotional Expression

To obtain data regarding participant's displays of positive and negative emotion, video cameras monitored and recorded participant's faces throughout the experiment. We subjected each participants' video segments to analysis by the commercial face reading software FaceReader v. 6.1 (Noldus, 2015). FaceReader objectively rates the presence of facial cues typically present in eight basic emotion expressions (neutral, happy, surprise, anger, fear, sad, disgust, and contempt) as well as specific action units as defined by Paul Ekman's facial affect coding system (AUs 1, 2, 4, 5, 6, 7, 9, 10, 12, 14, 15, 17, 18, 20, 23, 24, 25, 26, 27, and 43) on a frame-by-frame basis (approximate sample rate of 30 Hz). FaceReader treats each expression as orthogonal, and thus computes a standardized score for each emotion between 0 (emotion not present at all in facial expression) and 1 (emotion fully present in facial expression). Therefore, at any given frame a subject might have a "neutral" score of 0.25, a "disgust" score of 0.78, and an "angry" score of 0.44. These scores do not represent "parts of the sum," but instead represent independent observations of how present facial cues typical of each of the expressions are during any particular frame. Overall, FaceReader generally has high accuracy for emotion expression and, to a lesser extent, AU identification. In one study, FaceReader v. 6.0 had higher emotion expression identification accuracy (88%) than human subjects (85%) on two standardized face sets measured (Lewinski, den Uyl, & Butler, 2014). FaceReader v. 6.0 also scored highly on AU identification with a FACS index of agreement with a master coder of 0.67[1]. For the present experiment, we primarily were interested in behavioral indicators of positive emotion. Thus, we

[1] Note that in order for a human rater to be a certified FACS coder, she or he must score a FACS index of agreement with a master coder of 0.70 or higher.

were interested in the generated codes for happiness as well as facial action units associated with smiling (AU 12 and AU 6). These codes were highly redundant in our analyses for the present study (happiness facial expressions are typically defined as comprising AUs 12 and 6) so we ultimately decided to just use the happiness codes for the current analyses. Future studies utilizing this dataset may include these measures if these are determined to provide unique information relative to that obtained from analyses investigating happy facial expressions.

Procedure

Participants arrived at the lab room and were greeted by a same-gender research assistant who obtained consent. Included in the consent form was an agreement to be videotaped during the session. Participants then completed a series of self-report measures regarding their current health, use of any substances that might impact physiological measures, current depression, trait emotion measures, and ethnic identity. Following completion of these measures, the research assistant returned to the participant room to apply electrodes, test that the equipment was obtaining proper signals, and begin collection of physiological data. Following this set-up, the experimenter returned to the control room for the duration of the experiment, but was able to communicate with the participant via audio equipment.

Participants viewed a total of five films during this study selected for their previously demonstrated ability to induce target emotions (Gross & Levenson, 1995). Prior to viewing each film, a prompt on the computer screen instructed participants to empty the mind of "all thoughts, feelings, and memories." Next, a blank screen was displayed and baseline data was collected for one minute. Participants were instructed to watch the film and say "stop" if they found the film too distressing. Immediately after each film, there was a two-minute recovery period during which a blank screen was displayed. Emotion ratings were collected following the baseline

period and after each recovery period. Although participants viewed a total of five films, for this study, we were interested in observing participants' physiological reactivity to films 1 and 2 and reactivity to and recovery from film 2 (See Figure 1). Film 1 depicted seagulls flying and walking on a beach and was approximately 22 seconds in duration. This film was previously characterized as neutral and was not expected to elicit an emotional response. Film 2, selected for its previously demonstrated ability to induce disgust, depicted an eye operation and lasted 60 seconds.

The remaining films consisted of two disgust-inducing films (preceded by instructions to regulate their emotional response) followed by a relaxing film depicting various animals in nature. At the end of the experiment, the research assistant entered the room to remove the electrodes and debrief the participant.

Data analysis plan

Prior to analysis, a manipulation check will be conducted to confirm that the target emotion (disgust) was elicited by the stimulus. Reactivity and recovery levels will be calculated by obtaining mean levels of physiological indices during the pre-film baseline period, during the film, and for the first and second minute following the film.

Hypotheses 1, 2, and 3 will be evaluated using hierarchical regression models with physiological change score values as the dependent variable. This will be represented using the change score from baseline to video (reactivity) or video to post-film rest period (recovery) for the physiological measure of interest. The indicator of subjective or behavioral positive affectivity of interest will be entered into Step 1.

For Hypothesis 1, two series of regressions will be conducted to assess the impact of state positive emotion (defined as the mean aggregate score of emotion ratings for four positive

emotions) prior to the first film on 1) reactivity and 2) recovery. The same strategy will be used for Hypothesis 2 to measure the extent to which trait positive affect predict physiological reactivity and recovery to negative stimuli. One set of analyses will use the CES-D positive affect subscale as the predictor and the second set will use the SWLS as the trait measure of positive affect as the predictor. For Hypothesis 3, physiological indices of recovery will be entered as the dependent variables. The frequency of behavioral indicators of positive emotion (i.e., happiness codes), will be entered as the predictor.

For each of Hypotheses 1-3, a follow-up analysis will be conducted to examine whether the relationship between the various indicators of positivity and positive affect and physiological recovery is moderated by culture. To test these hypotheses we will add two additional steps to the original hierarchical regression models outlined above which use mean physiological recovery following the film as the dependent variable. The first step in the model will include the indicator of positivity or positive affect (e.g., CES-D positive affect, SWLS) score as a predictor. The second step will include the inclusion of three variables coded to represent our 4 ethnic groups consistent with the recommendation of Koeppel and Zedeck (1989). Finally, the third step will include the culture-by-positive affect interaction term. Predictors in these models will be centered before the computation of the interaction terms.

Chapter 3

RESULTS

Missing Data

Although the total sample comprised all behavioral, self-report data, and physiological data from 210 participants, a portion of this data was determined to be unusable. Across the physiological variables, approximately 30 to 50 percent of the data was excluded due to excessive participant movement leading to artifact error in the physiological data or to recording difficulties. Data loss affected all cultural groups. Data for 60 participants was not available for any of the physiological indices due to recording difficulties, comprising 24 European Americans, 15 Asian Americans, 7 Latinos, and 14 African Americans. An additional 14 participants' data was deemed unusable, comprising 5 European Americans, 2 Asian Americans, 1 Latino, and 6 African Americans. A chi-square analysis indicated that the groups did not differ significantly in the proportion of total data lost, $X^2 = 4.09$, $p = .25$. Finally, 17 participants stopped the videos at some point during the stimulus presentation, and were excluded from the final analysis, comprising 3 European Americans, 5 Asian Americans, 2 Latinos, and 7 African Americans. The proportion of participants across ethnicity that asked to stop the film was not significantly different, $X^2 = 5.63$, $p = .13$. Thus, a total of 119 participants' data was available for the current study. For some of the analyses presented below, the sample size analyzed may be smaller than 119, due to variation in complete data for specific physiological indices.

Preliminary Analyses and Manipulation Check

At baseline, the sample rated their positive emotions as 5.21 out of 8, reflecting their mean aggregate ratings for happiness, surprise, amusement, and contentment. Table 1 provides information regarding state and trait positivity values for the overall sample and for each cultural

group, and Table 2 displays correlations between key demographic variables, trait and state measures of emotion. Regarding the disgust induction, as seen in Table 3, the mean level of disgust following termination of the stimulus was rated as 2.56 out of 8 for the overall sample relative to a ratings of .41 prior to the film, indicating expected increases in disgust in response to the presented stimulus. Table 3 also displays the variation by group in the levels of self-reported disgust and facial expressions reflecting disgust. A one-way ANOVA revealed that these values reflect significantly different means among groups in their behavioral responses $F(3, 191) = 10.55$, $p = .000$, as well as in self-reported disgust $F(3, 206) = 2.7$, $p.047$. Asian Americans showed the most disgust in their facial expressions (M=.23) while also reporting a high level of self-reported disgust (M=3.08). However, African Americans reported the highest level of disgust (M=3.16), while displaying the lowest disgust on their face (M=.03).

Primary Analyses

Analyses investigating the study hypotheses are listed below. Due to the nature of the data analysis plan, the results include multiple tests for each hypothesis. In prior research, adjustments (such as a Bonferroni type correction) have been applied in order to enforce a more stringent criterion for statistical significance in such cases. However, others have highlighted problems with the recommendation to apply such corrections, and have suggested that such adjustments may limit, rather than enhance, what can be learned from study findings (Perneger, 1988; Glickman, Rao, & Schultz, 2014). In light of this, they recommend only applying adjustments to unplanned tests. As the results below do not include unplanned tests, the results will be presented without adjustment.

State Positive Affect

Table 4 presents the results of hierarchical regressions testing hypothesis 1that higher state positive affect (using positive emotion rating aggregate prior to film 1) predicts reduced reactivity to the disgust stimulus and better recovery following the disgust stimulus. The only significant result was in predicting RSA reactivity during the disgust stimulus from the positive emotion ratings, F (1,145) = 4.65, p=.033, R^2 = .031. This finding was consistent with Hypothesis 1, in that higher positive emotion ratings were associated with less reactivity to the disgust stimulus. As reflected in Table 4, significant findings did not emerge for any of the other sympathetic measures, heart rate or SCL. Table 4 also presents the results of including the positive emotion rating aggregate prior to film 1 as a predictor of the first and second minute of recovery following termination of the disgust stimulus. Positive emotion ratings were not significantly associated with physiological recovery for any of the variables examined.

The cultural moderation hypothesis predicted that Latinos who reported higher state positivity prior to the neutral film would show less reactivity to the disgust film and better recovery following the disgust film. To test whether there was a cultural moderation of the relationship between state positive affect and physiological recovery we added two additional steps to the above models which included positive emotion ratings as the first step. Step two added a set of three vector-coded variables that represented our four ethnic groups. Step three included the interaction terms between these vector-coded variables and positive emotion ratings capturing the moderating effect of culture on the relationship between state positive affect and physiological recovery. These additional analyses revealed a main effect of culture on heart rate recovery, F(4, 109) =4.34, p =.003, R^2 =.106, ΔR^2 = .106, $p_{\Delta F}$ = .005. A follow-up univariate ANOVA of the changes scores by ethnic group with post hoc comparisons using the Tukey HSD

test indicated that European Americans displayed more positive change scores for heart rate (M = 3.864), indicating better recovery than African Americans (M = -.266), who demonstrated less recovery following termination of the stimulus, d = -4.13, p = .016. Similarly, Asian Americans showed more positive change scores for heart rate (M=4.219) relative to African Americans, d =-4.49, p = .012. Contrary to hypothesis 1, there was no significant interaction between culture and state positive affect on heart rate recovery, $F(7, 106) = 2.43$, $p = .024$, $R^2 = .081$, $\Delta R^2 = .001$, $p_{\Delta F} = .989$. No additional significant findings emerged supporting a main effect of culture or an interaction of emotion ratings and culture for this hypothesis.

Trait Positive Affect

Hypothesis 2 tested whether higher trait positive affect (as measured via the positive affect score from the CES-D and SWLS score) predicts reduced reactivity to the disgust stimulus and better recovery following the disgust stimulus. Table 5 presents the results of hierarchical regressions with CES-D PA scores and SWLS as the predictors and our physiological reactivity and recovery variables as the dependent variables. Results of these analyses showed that CESD-PA scores did not predict physiological reactivity or recovery (either in the first or second minute) for any of the physiological change indices included.

We next investigated whether higher SWLS scores, which are related to higher trait positive affect, were associated with less reactivity to the disgust stimulus. The only physiological reactivity variable predicted by SWLS scores was SCL reactivity during the disgust film, $F(1,129) = 4.63$, $p = .033$, $R^2 = .035$. However, greater levels of SCL reactivity were associated with higher scores on the SWLS subscale, which was inconsistent with hypothesis 2. No other significant findings emerged for HR, RSA or sympathetic reactivity.

SWLS scores did not significantly predict physiological recovery during the first minute after the disgust film for any of our physiological variables. However, SWLS scores significantly predicted HR recovery during the second minute, F (1,113) = 6.29, p =.014, R^2 = .053. Given that disgust is associated with heart rate deceleration, better recovery would be defined as an increase in heart rate (positive change score). These findings support Hypothesis 2, in that higher SWLS scores were associated with a greater increase in HR values relative to lower SWLS scores.

To test for cultural moderation we again included two additional steps in the regressions depicted in Table 5, with the final one representing the trait positivity interaction with culture (either CES-D PA x culture or SWLS x culture). A significant culture x CES-D PA interaction emerged in predicting cardiac output, F(7, 99) =2.215, p= .039, R^2 =.135, ΔR^2 = .073, $p_{\Delta F}$ = .045 during the first minute of recovery. This interaction revealed that CO change scores were only predicted by CES-D PA scores for the African Americans (β =-.557, p =.016) and Latinos (β =.556, p =.025), but not for European Americans and Asians. While these findings demonstrate a cultural moderation, the direction of the results suggest that Latinos with higher CESD-PA scores showed poorer recovery, which is inconsistent with the study hypothesis. An additional culture X SWLS interaction emerged, F(7, 107) =2.22, p= .038,R_2 =.127, $R_{2\ change}$= .068, sig. F change=.045 during the second minute of recovery. Post-hoc tests indicated that HR change scores were only predicted by SWLS scores for Asian Americans (β=.439 p=.014) and African Americans (β=.519 p=.027), but not for European Americans and Latinos. These findings do not support our hypothesis, as a stronger association between SWLS scores and recovery did not emerge for Latinos. However, these data suggest that there is significant variation between cultural groups in recovery that is associated with SWLS scores.

Behavioral Indicators of Positivity

Hypothesis 3 investigates whether those who display more happy facial expressions during the neutral film display better physiological recovery. Similarly, this hypothesis tests whether those who display more happy facial expressions during the disgust inducing film will show better recovery following termination of the stimulus. Related action units, including AU06 and AU12, were not included in the results as these were found to be consistent with the results below investigating analysis of happiness displays.

Table 6 presents the results of hierarchical regressions assessing how emotion ratings prior to the first film are related to physiological reactivity across all our physiological indicators. Facial expressions of happiness during the neutral film were not related to recovery during the first or second minute across our physiological indicators.

We next observed whether more facial expressions of happiness during the disgust film predicted better recovery from the disgust stimulus. As seen in Table 6, analyses investigating HR, RSA, LVET, PEP, and SCL were not significant. However, behavioral displays of happiness did predict CO, F (1,104) = 4.38, p=.039, R^2 = .04, and SV, F (1,104) = 5.24, p=.024, R^2 = .048 during the first minute of recovery. In the second minute of recovery, significant results emerged for SV, F (1,106) = 4.26, p=.041, R^2 = .039. However, these findings did not support hypothesis 3, as a higher proportion of facial expressions of happiness was related to poorer recovery. There were no significant interactions between facial expression x culture interaction for either the neutral or disgust film.

Post-hoc Analyses

Given the research literature indicating that gender can influence the behavioral response to distressing stimuli (Ansfield, 2007), we conducted a post-hoc analyses to observe whether

there was a main effect of gender related to physiological recovery following the disgust film or whether gender and happiness displays during the disgust stimulus interacted to influence physiological recovery following the termination of the stimulus. Although, men and women did not differ in the level of disgust they displayed on their face during the disgust film, F (1,170) = 2.3, p =.13, women did display less happiness (M =.09) than men (M =.18), F (1,170) = 4.82, p =.029.

We next examined whether gender significantly predicted physiological recovery when included in the model along with happiness expressions. In these regression models, happiness displays were not significantly related to recovery in HR, RSA, LVET, PEP, CO or SCL during either the first or second minute of recovery. However, a main effect of gender emerged for SV, F (2,88) = 7.23, p=.001, R^2 = .14, ΔR^2 = .064, $p_{\Delta F}$ = .012 during the first minute of recovery. During the second minute of recovery, there was a main effect of gender predicting change in HR, F (2,96) = 3.91, p=.02, R^2 = .075, ΔR^2 = .075, $p_{\Delta F}$ = .006 and SV, F (2,90) = 6.47, p=.002, R^2 = .13, ΔR^2 = .063, $p_{\Delta F}$ = .012. There were no significant interactions between happiness expressions x gender in predicting recovery to the disgust film.

Table 1
Descriptive information for positivity measures (N = 210) and disgust ratings post induction

	Entire Sample	Latino	European American	Asian	African American
	210	38	75	52	45
Male	69	12	25	16	11
Female	124	23	41	22	31
Missing	33	3	9	14	3
	Mean	*Mean*	*Mean*	*Mean*	*Mean*
Age	19.67	20.48	18.89	20.53	19.61
Positive emotion aggregate	5.21	5.26	5.14	5.19	5.27
CES-D					
PA Subscale	7.1	7.03	6.83	7.29	7.4
PA Adjusted*	12.91	12.97	13.17	12.71	12.6
Satisfaction with Life Scale (SWLS)	23.61	25.32	24.63	22.5	21.64
Behavioral Happiness Neutral Film	.03	.01	.01	.05	.05
Behavioral Happiness Disgust Film	.05	.02	.018	.1	.07
Disgust Ratings post film	2.56	1.71	2.31	3.08	3.16

*Scores recoded so that higher scores indicate more positive affect

Table 2
Demographics and Positivity Measures: Correlations

	1	2	3	4	5	6	7	8
1. Emotion Ratings Time 1	_							
2. Emotion Ratings Time 2	.71**	_						
3. SWLS Life Satisfaction	.29**	.25**	_					
4. CES-D PA Trait Positivity	.24**	.12	.63**	_				
5. Happy Facial Expression video 1	-.12	-.09	-.1	-.06	_			
6. Happy Facial Expression video 2	-.07	-.001	-.05	.05	.27**	_		
7. Gender	-.07	-.07	.005	.07	-.05	.003	_	
8. Ethnicity	.04	-.09	-.13	-.07	.14*	-.1	-.01	_

Note. *p < .05, **p < .01, ***p< .00.

Table 3
Self-report, behavioral, and physiological changes in response to disgust induction

	Entire Sample			*Latino*			*Caucasian*			*Asian*			*African American*		
	Pre	Video	Post	Pre	Video	Post	Pre	Video	Post	Pre	Video	Post	Pre	Video	Post
Self-Reported Disgust	.41		2.56	.34		1.71	.41		2.31	.46		3.08	.42		3.16
Behavioral Disgust		.12			.06			.19			.23			.03	
HR	74.4	72.9	75.1	72	71.7	71.5	75.2	73.8	75.6	75.6	72.5	77.1	73.4	73.3	75.3
LVET	276.4	280.7	277	286.8	294.3	289.3	270	276.1	273.7	281.3	281	275.3	271.1	274.5	273.
PEP	111.9	111	114.8	112.5	109.7	113.5	111.8	111.9	116.8	110.5	109	113.3	113.9	113.7	115.2
CO	6.7	6.6	8.1	8	8.34	9.3	6.3	6.3	7.8	6.2	6	7.6	6.6	6.2	8.2
SV	90.4	90.3	108.5	112.6	114.5	128.8	82.3	83.8	104.4	84.3	84.4	100.4	92	85.6	107.5
RSA	6.5	6.6	6.5	6.7	6.7	6.6	6.4	6.4	6.4	6.1	6.4	6.2	7	7.1	7
SCL	2.6	2.5	1.91	3.2	3	2.7	2.7	2.1	2.1	2.1	1.4	1.4	1.9	1.6	1.14

Table 4

Summary of Regression Analysis for State Emotion ratings prior to Film 1 predicting physiological reactivity and recovery from the disgust stimulus (Hypothesis 1)

	F	*df*	*p*	R^2		*F*	*df*	*P*	R^2		*F*	*df*	*p*	R^2
Reactivity					Recovery m1					Recovery m2				
HR	1.77	1,146	.19	.012	HR					HR				
RSA	4.65	1,145	.03*	.031	RSA	3.65	1,112	.06	.032	RSA	2.15	1,113	.15	.019
LVET	2.19	1,145	.14	.015	LVET	.46	1,111	.5	.004	LVET	.55	1,112	.46	.005
CO	.05	1,146	.82	.000	CO	.19	1,105	.66	.002	CO	.04	1,107	.84	.000
SV	.11	1,146	.74	.001	SV	.44	1,105	.51	.004	SV	.77	1,107	.38	.007
PEP	2.94	1,145	.09	.020	PEP	.19	1,105	.66	.002	PEP	.39	1,107	.54	.004
SCL	1.37	1,129	.24	.011	SCL	.05	1,105	.82	.000	SCL	.05	1,107	.82	.000
						X	1,101	.23	.014		1.47	1,101	.23	.014

Note. *p < .05, **p < .01, ***p< .00.

Table 5

Summary of Regression Analysis for Trait emotions predicting physiological reactivity and recovery from the disgust stimulus (Hypothesis 2)

	F	*Df*	*p*	R^2		*F*	*df*	*P*	R^2		*F*	*df*	*p*	R^2
CES-D PA														
Reactivity					Recovery Minute 1					Recovery Minute 2				
HR	.28	1,146	.6	.00	HR	1.10	1,112	.32	.01	HR	1.5	1,113	.22	.01
RSA	.2	1,145	.66	.00	RSA	1.54	1,111	.22	.01	RSA	1.29	1,112	.26	.01
LVET	.26	1,146	.61	.00	LVET	.00	1,105	.97	.00	LVET	.02	1,107	.89	.00
CO	.49	1,146	.49	.00	CO	.27	1,105	.6	.00	CO	.29	1,107	.6	.00
SV	.27	1,146	.27	.00	SV	.51	1,105	.67	.00	SV	.52	1,107	.47	.01
PEP	.15	1,146	.7	.00	PEP	.14	1,105	.71	.00	PEP	.5	1,107	.48	.01
SCL	3.56	1,129	.06	.03	SCL	.85	1,101	.36	.01	SCL	.94	1,101	.34	.01
SWLS					Recovery					Recovery				
Reactivity					Minute1					Minute 2				
HR	1.61	1,146	.21	.01	HR	2.21	1,112	.14	.02	HR	6.29	1,113	.01*	.05
RSA	.4	1,145	.53	.00	RSA	.33	1,111	.57	.00	RSA	2.61	1,112	.11	.02
LVET	.03	1,146	.87	.00	LVET	.07	1,105	.83	.00	LVET	.07	1,107	.79	.00
CO	.9	1,146	.35	.01	CO	.7	1,105	.41	.01	CO	.59	1,107	.44	.01
SV	.18	1,146	.67	.00	SV	.09	1,105	.76	.00	SV	.00	1,107	.99	.00
PEP	.1	1,146	.75	.00	PEP	.27	1,105	.63	.00	PEP	.06	1,107	.81	.00
SCL	4.63	1,129	.03*	.04	SCL	1.48	1,101	.23	.00	SCL	1.46	1,101	.23	.01

Note. *p < .05, **p < .01, ***p< .00.

Table 6

Summary of Regression Analysis for happy facial expressions to the neutral and disgust films predicting physiological recovery from disgust stimulus (Hypothesis 3). Significant results are in italics for emphasis.

	F	*Df*	*p*	R^2		*F*	*Df*	*p*	R^2
Recovery Minute 1					Recovery Minute 2				
HR	.00	1,111	.96	.00	HR	1.62	1,112	.21	.01
RSA	.1	1,110	.75	.00	RSA	.85	1,111	.36	.01
LVET	.02	1,104	.89	.00	LVET	.06	1,106	.81	.00
CO	.75	1,104	.39	.00	CO	.90	1,106	.35	.01
SV	.46	1,104	.66	.00	SV	.88	1,106	.35	.01
PEP	.04	1,104	.83	.00	PEP	.06	1,106	.81	.00
SCL	1.99	1,99	.16	.02	SCL	1.5	1,99	.22	.02
Film 2 Minute 1					Minute 2				
HR	.89	1,112	.35	.01	HR	.02	1,112	.88	.00
RSA	1.03	1,111	.31	.01	RSA	.24	1,111	.62	.00
LVET	1.24	1,104	.27	.01	LVET	1.14	1,106	.29	.01
CO	*4.38*	*1,104*	*.04**	*.04*	CO	3.72	1,106	.06	.03
SV	*5.24*	*1,104*	*.02**	*.05*	*SV*	*4.26*	*1,106*	*.04**	*.04*
PEP	.17	1,104	.69	.00	PEP	.41	1,106	.52	.00
SCL	3.86	1,100	.05	.04	SCL	3.33	1,100	.07	.03

Note. *p < .05, **p < .01, ***p< .00.

Figure 1. Flowchart of experimental procedures

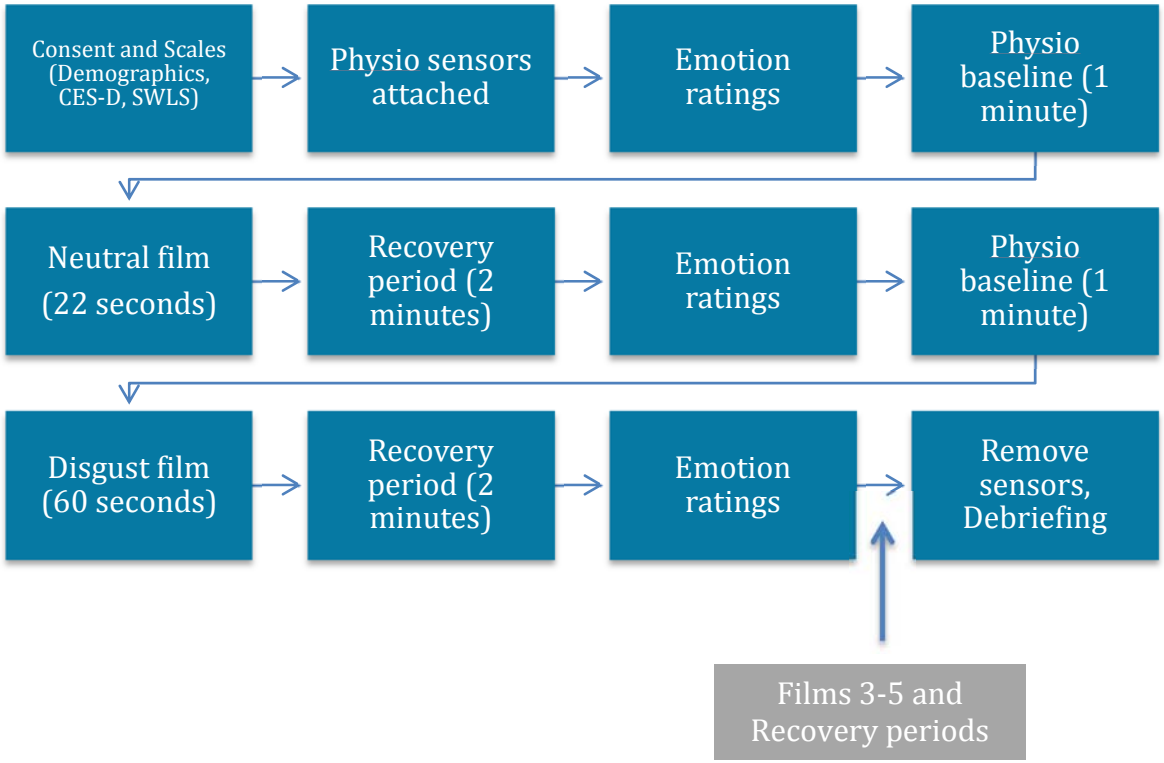
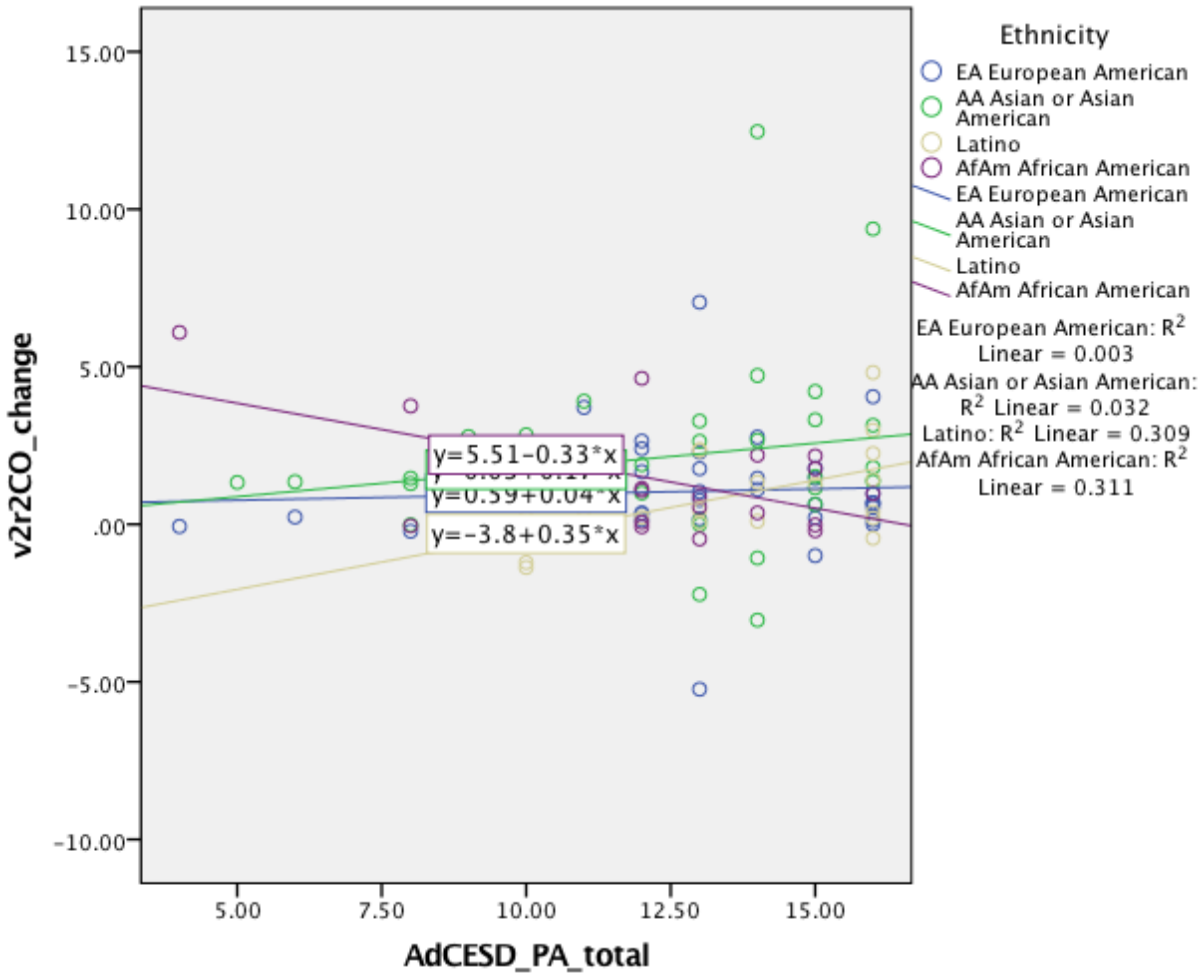


Figure 2. Trait Positivity x Culture Interaction predicting cardiac output recovery from film to recovery



Chapter 4

DISCUSSION

The current study sought to investigate whether positivity can be beneficial in the face of negative emotional challenges. Based on previous research demonstrating a protective buffering or undoing effect of positive emotions, we hypothesized that positive emotions (operationalized in various ways) might limit reactivity and promote recovery from a disgust induction. Specifically, we used measures of trait and state positivity to investigate how either the tendency to experience positivity or feeling positive in the moment impact physiological reactivity to and recovery from a disgust-eliciting film clip. Both self-report data, including self-report measures and emotion ratings, as well as behavioral data observing facial expressions of positivity, were included. The study results provided mixed support for our hypotheses. In most cases, positivity was found to be unrelated to reactivity and recovery. In cases were positivity was associated with reactivity or recovery, there was mixed support for the study hypotheses, and the direction of the relationships of physiological indices to positivity were not always as expected.

Additionally, this study also sought to understand how the possible protective effects of positivity might be moderated by culture, given variation among cultures in norms for the experience and expression of positive emotions. In particular, we hypothesized that due to the emphasis on positivity in Latino cultures and the emphasis on emotional balance in Asian cultures, that these groups might show stronger relationships between positivity and physiological reactivity and recovery relative to the European American and African American groups. Once again, we received mixed support for the cultural moderation hypothesis. While there was some support for Asian Americans displaying better recovery relative to other cultural

groups, positivity was less related to recovery for Latino participants, as had been predicted, relative to other cultural groups.

State positive affect

Higher positive emotion ratings prior to the first film were associated with reduced RSA reactivity, indicative of less increase from baseline to video in parasympathetic response to the disgust stimulus, relative to greater increases for those with lower positive emotion ratings. This supported hypothesis 1, indicating that feeling positive prior to a negative stimulus may confer a buffering effect that limits reactivity. Given that disgust has been associated with both sympathetic and parasympathetic response, this finding suggests that higher positivity prior to a stimulus may serve a protective function by limiting the response to disgust in the parasympathetic domain.

However, the null findings across the remainder of the physiological variables indicate that the buffering effect of positive emotion on physiological reactivity did not extend to sympathetic activation. It may be that the mean aggregate used to conceptualize state positive emotions, which included amusement, contentment, happiness, and interest, does not capture the types of positive emotion that confer a buffering effect. While many studies of positive emotions have looked specifically at happiness and joy (Kaplan and Camacho, 1983; Zuckerman, Kasl, & Ostfeld, 1984), or existing measures such as the Positive and Negative Affect Scale (PANAS), the aggregate used in the current study has been less utilized. Of note, the aggregate utilized in this study also does not include high arousal positive emotions such as excitement or enthusiasm that may be more closely tied to physiological arousal (Pressman and Cohen, 2005).

We predicted that those with higher ratings of state positivity at the beginning of the study would experience less physiological reactivity to the disgust stimulus. While the RSA

finding supports our hypotheses, it is unclear whether this response truly represents a more positive or desirable outcome. The fact that state positivity was associated with reduced RSA reactivity, which is understood to be parasympthatically mediated, but unrelated to sympathetically-mediated physiological responses points to the complexity of RSA activity. RSA activity is associated with the body's regulatory system, and thus lower levels of reactivity may be an indication that the body is not in need of regulation at the present time, or that the regulatory system is failing to activate. Also, as noted above, disgust does not follow the physiological activation pattern associated with many other negative emotions, and is also complicated by factors such as seemingly positive responses (i.e. laughter) that some individuals might display in response to disgust. Because some components of the disgust response, such as heart rate deceleration, look similar to what we typically view as a relaxation or parasympathetic response, interpretation of the RSA results leave room for multiple interpretation in ways that the self-report data do not. Further clarity regarding how each of the physiological indices included in this study change in response to disgust will inform future studies of recovery following disgust. Additionally, inclusion of other physiological responses to study designs, such as muscle tension, may further help to distinguish the extent to which individuals' regulatory systems are operating.

Similarly, distinguishing reactivity from recovery is another challenge within the current study, given that reactivity may persist well into the recovery period, thus making it difficult to identify the point at which regulating mechanisms commence. While this is a challenge to disentangle within the current study, one approach to address this in the future might be to further separate the recovery periods, in order to observe how responses after the initial 10, 20, or 30 seconds vary from the latter part of the recovery period. This may clarify at what point

reactivity appears to cease. As the overall study included 2 additional disgust films that were not included in the present study, there may be ample opportunity to observe whether a physiological pattern appears to be present that clarifies the point at which reactivity gives way to the recovery period.

Trait positive affect

We investigated the impact of trait positive emotions using the CES-D PA and the impact of life satisfaction using the SWLS. Although trait positivity was not related to reactivity or recovery across the full sample, higher life satisfaction was associated with increased SCL reactivity. However, the direction of this result was inconsistent with our hypothesis. As suggested in Papousek et al. (2010) above, individuals who tend to be more positive may find a negative task unexpected and surprising, resulting in greater physiological arousal. This may have occurred in the present study, in which participants were unaware of the nature of the videos that would be displayed. Given the contrast between the neutral and disgust films, the participants may not have immediately realized the nature of the film, which could have increased the surprising nature of the stimuli, magnifying this effect.

During the recovery period, however, those with higher life satisfaction scores displayed better heart rate recovery, consistent with our hypothesis, and supporting the idea of a beneficial undoing effect of positive emotion. While the CES-D PA measures trait positivity over the past week, the assessment of life satisfaction may be more reflective of a person's outlook or a perspective that is more stable. Thus, it may be more susceptible to be disrupted by surprising events, while also being related to patterns of healthy recovery for those with high scores. Additionally, as heart rate reflects the influence of both sympathetic and parasympathetic

response systems, it may be that physiological responses that include parasympathetic activity are more highly influenced by positivity.

Behavioral Positivity

Finally, facial expressions of happiness during the disgust film predicted cardiac output and stroke volume recovery, but resulted in null findings for the remainder of our physiological variables. Those who displayed more facial expressions of happiness during the film exhibited poorer recovery with regard to cardiac output and stroke volume, indicating an increase in these values from the film to the recovery period rather than the expected decrease. This was contrary to our study hypotheses. However, given the complexity of physiological responding to disgust, these results can also be conceptualized as reflecting better regulation. The extent to which the heart rate findings are supportive of our hypothesis depends on the extent to which the deceleration typically observed in disgust responding reflects parasympathetic versus sympathetic influences. If the deceleration is primarily driven by decreased SNS input to the heart (less excitation), then we might also expect to observe a pattern of decreases in cardiac output and stroke volume, and better recovery would be reflected by a post-film increase in scores, as observed in the current study. This second interpretation appears to provide a more consistent picture in line with the other study findings, and thus, based on these results and the difficulty in interpreting cardiac output and stroke volume responses to disgust, we believe these findings to be more reflective of decreased SNS input on the heart and better recovery.

Regarding the use of facial expressions displaying positivity, some studies of behavioral positivity have used a dichotomous approach, for example observing whether participants smiled at least once or not at all during presentation of a stimulus (Fredrickson & Levenson, 1998). Use of this approach may have presented a clearer picture or more clear analyses of the role of

behavioral positivity, as most participants were found not to display positivity during the disgust film. Comparing this subset of participants to the group that displayed any positivity might strengthen such analyses. This approach may also have provided additional information regarding how gender influenced responding to the disgust stimuli. Our findings for gender revealed that there was a significant difference between men and women in facial expressions of happiness during the disgust film. There were also some gender effects on physiological recovery, which may reflect sex differences in recovery following exposure to disgust. However, we did not observe any interactions between happiness displays and gender, and utilization of a dichotomous approach might better speak to whether gender and happiness displays operate differently for the two genders. Conceptually, the ability to generate or experience any positivity during a disgust-inducing task may be reflective of strong coping skills that are easily accessible. Thus the presence or absence of positivity may be a more informative measure than the frequency of positive expressions.

Cultural Moderation

An important emphasis of the current project was to determine whether culture moderates the predicted relationships between indices of positive affect and responses to the disgust stimuli. Of note, there were differences between the groups in their self-reported disgust following the disgust stimuli as well as facial expressions of disgust during the stimulus presentation. Based on self-report, African Americans experienced the most disgust, followed by Asians, European Americans, and Latinos. Facial expressions indicated that Asian Americans displayed the most disgust, while African Americans and Latinos displayed very little disgust during presentation of the stimulus. This pattern of findings for Asian Americans is surprising given that the norms of this group generally allow for less independent self-expression relative to the other groups

included. One possible explanation is that the Asian Americans in this study may be more highly acculturated to Western norms regarding emotions, given their residence in the US, the enrollment of most of the sample in a US university, and much of the sample having been born in the US. Although eligibility criteria were selected in order to increase the likelihood of identification with the culture of origin, it may be that the sample included more individuals who ascribe to Western norms. Alternately, it may be that the disgust-inducing nature of the task was highly distressing and of a visceral nature relative to other types of negative emotional experiences (Stark et al., 2005), such that it would override the tendency to keep emotions in balance or to manage display of emotions in this group. That the Latino group reported and displayed little response to the disgust film was also surprising, especially as their behavioral responding was found to be unrelated to positivity. This may speak to additional emotion norms that apply specifically to disgust-inducing challenges, an area for further consideration. Alternately, this may reflect reluctance within the Latino group to report experiencing negative emotion as well as a likelihood to mask negative emotions in order to maintain consistency with emotion norms that emphasize the expression of positive emotions (Triandis et al., 1984; Holloway et al., 2009). This group may experience greater discomfort with or lower motivation to express negative emotions within the study protocol if this group's emotion norms do not support the notion that such displays or reports would serve an important function.

We did find that culture moderated change in heart rate during the first minute of recovery, such that European Americans and Asian Americans showed better recovery relative to African Americans, who displayed the poorest heart rate recovery among the cultural groups. As noted earlier, African Americans experience the highest rates of cardiovascular disease and death relative to the other cultural groups included in this study (Go et al., 2014; Ford, 2014). The

research in this area indicates that these elevated rates of illness are attributable to some extent to experiences of racial discrimination, internalization of negative racial bias (Chae et al., 2014), disparities in access to health care, and factors related to socioeconomic status, such as living in disadvantaged neighborhoods (Barber, Hickson, Kawachi, Subramanian, & Earls, 2015). However, the current study suggests that this cultural group may struggle to regulate cardiac-relevant outcomes even in the absence of such experiences within a controlled laboratory setting. Thus, chronic experiences related to their social oppression, may contribute to the observed outcomes among our African American sample and may further increase risk of cardiac illness should this pattern of recovery persist consistently across multiple small stressors. It may therefore be important to directly address such patterns of recovery by providing education about ways to positively impact recovery during a stressful moment, in conjunction with interventions aimed at reducing health disparities and interventions aimed to positively impact psychosocial factors related to cardiovascular disease for this group.

Finally, given this cultural groups' history of abuse by the medical and research communities, past research has revealed that African Americans report a greater mistrust of research relative to other cultural groups (Rajack-Talley et al., 2017; Soto et al. 2012). If such mistrust was present during the present study, this may have influenced the recovery rates for this group, especially following presentation of a surprising, distressing, and disgust-inducing task. Future studies may benefit from inclusion of measure or questionnaires designed to assess levels of mistrust of research, which would allow for investigation of the extent to which poorer physiological outcomes are related to levels of trust.

In contrast, culture was not related to heart rate recovery for Latinos, which again was inconsistent with study hypotheses that this group would show a stronger relationship between

positivity and recovery due to cultural norms. However, given that the purpose of such norms within the Latino culture are to promote interpersonal harmony (Triandis et al., 1984; Holloway et al., 2009), the non-social nature of this experiment may have impeded the activation of this norm. The presence of others has been found to activate norms related to display and regulation of affective responses (Ansfield, 2007). Because the study was conducted alone, and the distressing task was not related to an interpersonal topic, this may not have been a situation where the use of positivity to promote recovery or reestablish balance would have been relevant for Latino participants given the interpersonal nature of this group's emotion norms.

During the second minute of recovery there was an interaction between culture and life satisfaction scores predicting heart rate recovery for African Americans and Asian Americans only. Finally, a significant interaction between CESD-PA scores and culture predicted cardiac output during both minutes of recovery for African Americans and Latinos. This interaction revealed that Latinos who reported more trait positivity showed poorer recovery, which was inconsistent with study hypotheses, and provides more support for the idea that higher levels of positivity are influential in reference to recovery and responding to physiological indices influenced by the parasympathetic system.

Limitations and Future Directions

A limitation of the current findings is the unequal group sizes that occurred due to a large portion of the psychophysiological data being unusable and the data loss occurring unevenly across groups. While this was not as problematic when conducting analyses for the overall sample, it does reduce the power for our cultural moderation hypothesis. In future studies, in may be helpful to recruit larger samples to account for possible loss of data, or to periodically assess the usability of data throughout data collection.

Additionally the ability of participants to stop the film if they found the experience too distressing contributed to an unexpected loss of data and resulted in a self-selection bias among the study completers. It may be that a sample that is able to tolerate viewing the films responds differently to disgust than individuals who choose to withdraw from the study. Furthermore, the study likely included individuals who did not request that the films be stopped, but who avoided watching the films, for example, by physically turning away from the films or closing their eyes. When this behavior was noted during the protocol by the experimenters, study participants were asked to redirect their attention to the study stimuli. However, participants may not have complied or may not have been able to continue to engage with the stimuli throughout the duration of the presented films. Future studies may benefit from considering how the use of avoidance as a coping mechanism in such instances is related to both state and trait positivity, physiological responding, and whether these relationships vary by cultural group. Even though chi-square analyses indicated that there were no differences across groups in the percentage of participants that asked to stop the film, there may still be a difference between those who engaged with the stimulus and those who avoided engagement. For those groups encouraged to maintain positivity, particularly the Latino group, avoidance of the stimuli may have served as one way to limit negative affectivity, which could also speak to the significantly lower levels of displayed and reported disgust in this cultural group.

Investigating the beliefs that members of such groups hold around the introduction of negative affect may further illuminate their response patterns. It may be that some groups endorse beliefs that are more consistent with particular theories of positive emotion. For example, it may be that Latinos may hold beliefs consistent with Zautra's Dynamic Model of Affect (Zautra et al., 2005), such that maintaining a high level of positive affect during a stressful

task would serve to limit the extent to which they experience negative affect given the hypothesized inverse relationship between these factors. Such beliefs may influence response and recovery patterns within and between groups, and is an area that may benefit from future study.

How to study disgust responding and recovery in individuals who choose not to participate or who avoid engaging with disgust-inducing stimuli is an important question to consider. While methods utilizing ecological momentary assessment may allow us to gather more valid self-report data regarding individuals' responses to disgust-eliciting situations, this approach would make it difficult to carefully control the variables of interest or identify mechanisms that may be driving a particular pattern of responses. Within the laboratory, the use of graduated hierarchies of stimuli similar to those used in studies of fear responding (Kircanski et al., 2011) may increase the likelihood that these individuals will tolerate the stimuli.

Another limitation of the study design is that disgust ratings were not collected until the end of the recovery period, two minutes after termination of the disgust stimulus. Although this allowed physiological data to be collected without interference, it is unclear whether individuals were self-regulating their emotions during this two-minute period, in which case group differences in disgust ratings may reflect recovery from disgust in some groups versus true differences in baseline levels of disgust. While behavioral data during the film allows for measurement during exposure to disgust stimulus, such displays may be influenced by display rules.

The current study provided limited support for a protective buffering or undoing effect of positivity. While it may be that positivity is unrelated to physiological recovery and responding to disgust, the measurements of positivity utilized in this study may not have fully captured study

participants emotional experience. Although this study included numerous measures of positivity, the original study was not designed to investigate the role of positivity. Nevertheless, our data can inform future methodological consideration that will help us more fully understand the possibly protective mechanisms of positivity. For example, periodically checking with participants throughout the day regarding their emotional state may provide a more accurate depiction of participants' tendency to be positive as well as the variability in their positive emotions. Recent studies have found that this type of longitudinal measurement may be more reliable than participant's self report of their emotional state, which might be influenced by current stressors or responding biases. Regarding self-report ratings, future studies might include a larger range of emotions, including both high and low arousal positive emotions.

Finally, while the use of a laboratory paradigm allows for isolation of specific variables, much of the benefit that individuals derive from positive emotions occurs outside of laboratory settings. Thus, it is important to observe the ways positive emotions provide a protective benefit over time in *and* outside of the laboratory.

Conclusion

The current study adds to our knowledge regarding the contribution of positivity to physiological responding. As apparent from the study findings, contrary to popular ideas about positive emotions, results were mixed and such emotions did not consistently provide a benefit to participants, and did not consistently support the Broaden-and-Build of positive emotions, which was the basis for the current study. Life satisfaction, trait positivity, and positive emotion ratings were related to some aspects of physiological responding, but not always in the directions hypothesized. Given this variation in results, sometimes in unexpected directions, this study suggests that positive emotions do not always confer a buffering effect from negative affect

related to emotionally challenging situations, and may not always be protective in that they serve to temper responses and speed recovery. However, the findings support the notion that culture influences how and for whom positive emotions are beneficial. A surprising finding was that positivity did not contribute to better reactivity or recovery for Latinos, and that this group also reported the lowest levels of disgust in response to the disgust stimulus. There may be a need for modification of the stimulus used to study emotional responding in this group, or further investigation of the types of situations in which norms for positive emotions are activated and confer a benefit. The overall pattern of responding suggested that positivity may play a role in physiological responses that are, in part, tied to the parasympathetic nervous system, but may be less relevant or prolong activation in relation to sympathetic responding. The current study suggests that there is a need for further refinement of theories of positive emotions, and that consideration of culture may further illuminate in what situations and for whom these emotions serve a benefit.

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Vita

Arezou Mortazavi, M.Ed., M.S.

370 Moore Building ◆ University Park, PA 16802
aum253@psu.edu

Education

Expected Summer 2017	**The Pennsylvania State University, University Park, PA** Doctoral Candidate, Ph.D. program Department of Psychology, Adult Clinical Psychology Track
2014	**The Pennsylvania State University, University Park, PA** Master of Science, Clinical Psychology
2007	**Harvard Graduate School of Education, Cambridge, MA** Master of Education, Human Development and Psychology
2005	**University of California, Los Angeles** Bachelor of Arts, Psychology
2002-2003	**Bristol University, Bristol, United Kingdom** Education Abroad Program

Publications

Mortazavi, A., Soto, J.A., & Jacobson, N. (under revision). Positive emotion, drinking motivations, and problematic drinking: A case for cultural variation. Manuscript submitted for publication.

Mortazavi, A., Youn, S.J., Castonguay, L., & Newman, M.G. (2013). Treating Generalized Anxiety Disorder. In L. Grossman & S. Walfish (Eds.), *Translating Research into Practice: A Reference for Practicing Mental Health Professionals*. New York, NY: Springer Publishing Company.

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