POSITIVE AFFECT AND CARDIOVASCULAR REACTIVITY IN RESPONSE TO SOCIAL VERSUS NON-SOCIAL LABORATORY STRESSORS

By

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POSITIVE AFFECT AND CARDIOVASCULAR REACTIVITY IN RESPONSE TO SOCIAL VERSUS NON-SOCIAL LABORATORY STRESSORS

Abstract

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Increasing evidence suggests that positive affect may have a beneficial or protective effect on cardiovascular health. Laboratory investigations suggest that this relationship may be influenced by associations between personality characteristics and the magnitude and duration of acute cardiovascular responses to stress. Specifically, positive affect may associated with less (lower magnitude and duration) cardiovascular reactivity (CVR) to stress (Raikkonen et al., 1999). Prior research suggests that negative dispositions such as hostility are more reactive to social as opposed to non-social stressors (Smith & Gallo, 2001). The present study sought to examine whether reduced stress reactions are more evident in social versus non-social stressors to identify a potential mechanism in the relationship between dispositional positive affect (DPA) and health outcome. A sample of 90 undergraduate men and women completed the Positive and Negative Affect Schedule – Extended Version (PANAS-X; Watson & Clark, 1994) followed by a counterbalanced, within-subjects lab protocol involving cold pressor (non-social) and self-disclosure speech (social) tasks. Cardiovascular reactivity and recovery as well as state affect were assessed for both tasks. Multiple regression analyses revealed that participants higher in dispositional negative affect (DNA) experienced greater increases in systolic blood pressure (SBP) and medial arterial pressure (MAP), *t*s > 1.66, *p*s < .10, as well as more anxiety and anger,

*t*s > 1.78, *p*s < .08 and less happiness, *t*s < -1.98, *p*s < .053, during the disclosure task. Multiple regression analyses revealed that participants higher in DPA showed greater decreases in SBP and MAP during the recovery portion of the disclosure task, *t*s < -1.66, *p*s < .10. These findings suggest that during a social stressor, individuals higher in DNA may experience greater CVR, whereas individuals higher in DPA are able to more quickly recover following a social stressor. Additionally, during the cold pressor task, higher DPA was associated with decreased heart rate in women and decreased MAP in all participants, *t*s < -1.76, *p*s < .085, but no significant effects were found for DPA and cold pressor recovery.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of death in the United States, accounting for more deaths than cancer, chronic lower respiratory diseases, accidents, and diabetes mellitus combined (Rosamond et al., 2007). According to the American Heart Association nearly 16 million American adults have coronary heart disease (CHD), the most prevalent form of CVD. Coronary heart disease is characterized by the progressive narrowing of the coronary arteries due to atherogenesis, the development of plaque in the lining of the coronary arteries (Ross, 1999). As the plaque enlarges, blood flow to the heart is reduced, which may cause insufficient blood flow to the heart tissue (i.e., ischemia) leading to chest discomfort and myocardial infarction (MI: heart attack). In addition, the plaque may rupture creating a thrombus or particle that may become lodged downstream creating an acute ischemic event distal to the blockage. This cascade of events is responsible for approximately 865,000 myocardial infarctions and 1 of every 5 deaths each year (Rosamond et al., 2007).

Risk factors for CHD can be non-modifiable or modifiable. Non-modifiable risk factors include age, male gender, and genetics or family history. Importantly, age and gender interact to produce different lifetime risk trajectories. The lifetime risk of developing CHD after age 40 years is one in two for men and one in three for women (Lloyd-Jones, Larson, Beiser, & Levy, 1999). Modifiable risk factors include smoking, hypertension, high cholesterol, diabetes mellitus, physical inactivity, and being overweight or obese. In a recent review, Magnus and Beaglehole (2001) found that smoking, high cholesterol, and high blood pressure accounted for 75% of risk for coronary heart disease. Similar findings have been reported elsewhere (Stamler et al., 1999; Stampfer, Hu, Manson, Rimm, & Willett, 2000; Yusuf et al., 2004). As indicated by current

literature, traditional risk factors account for the majority of the variance in CHD risk. However, a significant portion of CHD risk remains unexplained.

Psychosocial factors refer to individual difference characteristics such as personality and dispositional affect as well as social conditions such as social resources, socioeconomic status, and characteristics of the social environment. In addition to influencing a person's daily experiences, psychosocial factors may also influence disease risk. For example, depression, anxiety, and related individual differences accounted for approximately 28% of the variance in MI risk in the INTERHEART case-control study of 29,000 participants in 52 countries. This rate was slightly less than the risk associated with smoking and greater than hypertension or obesity (Yusuf et al., 2004). Similar findings across the literature increasingly support psychosocial factors as causal determinants of CHD and sudden cardiac death (Everson-Rose & Lewis, 2005; Hemingway, Malik, & Marmot, 2001; Hemingway & Marmot, 1999; Smith & Ruiz, 2002).

Negative dispositions such as anger, hostility, and depression constitute the majority of research on individual differences and health (Smith, Glazer, Ruiz, & Gallo, 2004; Smith & MacKenzie, 2006; Smith & Ruiz, 2002). Individuals high in anger have been shown to have increased rates of atherosclerosis (Räikkönen, Matthews, Sutton-Tyrrell, & Kuller, 2004) and CHD morbidity and mortality (Williams et al., 2000). Hostility is positively associated with elevated levels of inflammation (Graham et al., 2006), coronary artery calcification (Smith et al., 2007), risk of hypertension (Yan et al., 2003), higher mortality in adults under 60 years (Boyle et al., 2005), and poorer survival in patients with coronary artery disease (Boyle et al., 2004). Hostile individuals also display significantly greater blood pressure reactivity during and poorer recovery from laboratory stressors (Christensen & Smith, 1993; Rhodes, Harrison, & Demaree, 2002; Ruiz, Uchino, & Smith, 2006; Suarez & Williams, 1990) and have higher ambulatory

blood pressure and heart rate during periods of negative mood (Räikkönen, Matthews, Flory, & Owens, 1999). Depressed affect is also associated with CHD risk including ischemic heart disease (Anda et al., 1993) and increased mortality due to cardiovascular causes (Barefoot & Schroll, 1996; Schulz et al., 2000). In a recent review, Suls and Bunde (2005) argue that these similarities in disease prevalence and cardiovascular outcomes support the possibility that a general disposition toward negative affectivity may be more important for disease risk than any specific negative affect. Dispositional negative affect (DNA) has been demonstrated to positively relate to incidence of CHD (Todaro, Shen, Niaura, Spiro, & Ward, 2003), and several reviews support this relationship (Kubzansky & Kawachi, 2000; Sirois & Burg, 2003).

Positive Affect

In contrast to the detrimental effects of negative dispositions, folklore has long endorsed the health benefits of trait happiness or dispositional positive affect (DPA). Positive affect (PA) can be defined as the feelings that reflect a level of being engaged in a pleasurable way (Watson, Clark, & Tellegen, 1984), such as enthusiastic, interested, friendly, active, and happy. This affective experience can be brief, longer lasting, or more stable and trait-like.

Positive affect is often assessed through self-report. Measures can be worded to fit the time interests of the research such as "right now, at this moment" or "in general." Bradburn and colleagues (1965; 1969) were among the first to propose that happiness is composed of both positive and negative affect. To measure happiness they created a scale consisting of ten items, five measuring PA (Positive Affect Scale or PAS) and five measuring NA (Negative Affect Scale or NAS). Another early measure of positive emotions is the Profile of Mood States scale (POMS; McNair, Lorr, & Droppleman, 1971), which contains vigor as the only subscale that

assesses PA. Items include *cheerful*, *active*, *lively*, and *alert* and are rated according to how the person generally feels on a 0 to 5 point scale. The Positive Affect and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) is a commonly used self-report measure of positive affect that was designed to measure PA and NA as orthogonal (versus bipolar) dimensions by creating separate 10-item scales for each. The PA scale is rated on a 5-point Likert scale and is comprised of the descriptors *attentive, alert, inspired, determined*, *interested, active*, *excited*, *enthusiasti*c, *strong*, and *proud*. The PANAS can be administered with short-term instructions (measuring states; e.g. "right now" or "today") or longer-term instructions (trait-like; e.g. "past year" or "in general"). The Positive and Negative Affect Schedule Extended Form (PANAS-X; Watson & Clark, 1994) is an alternate 60-item self-report instrument rated on a 5-point scale that is designed to measure PA and NA as well as some additional affective states, such as *serenity, fatigue*, and *surprise*. Tugade and Fredrickson (2004) use an alternate approach to measuring positive affect that is based on the broaden-and-build theory of positive emotions, in which positive emotion, termed "positive emotional granularity" (Tugade, Fredrickson, & Feldman Barrett, 2004), is an integral part of trait resilience. Thus, their measure includes a trait resilience measure, the Ego-Resiliency Scale (Block & Kremen, 1996), and a modified PANAS (with state or "right now" ratings) that is comprised of the original ten PA and ten NA terms as well as 18 additional affective terms (*amused, angry, anxious, blue, calm, content, curious, depressed, disappointed, discouraged, disgusted, happy, relaxed, relieved, sad, satisfied, surprised, tired*). All affective terms were subjected to a principle-component factor-analysis that yielded two dominant factors: Positive mood scale and negative mood scale. Another frequently used measure of positive affectivity is a modified version of the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977), which contains four positively worded items to

measure PA (Ostir, Ottenbacher, & Markides, 2004). The items, rated on a 4-point scale, include feeling happy, feeling hopeful about the future, being just as good as other people, and enjoying life.

The aforementioned methods all rely on one-time administration of a trait measure. An alternate method for assessing stability of affect is through aggregated state reports taken throughout the day or over several days. For example, Steptoe and colleagues (2007; 2005) use an ecological momentary assessment (EMA) technique in which the single item *happiness* (on a 5-point scale) is assessed on multiple occasions across several days to get an aggregate of scores. Similarly, Cohen and colleagues (2003) use a variant of the PANAS-X to assess emotional styles. Their measure contains 9 positive and 9 negative items to be rated on a 4-point Likert scale for how participants have felt during the last day. Seven consecutive daily scores are averaged to obtain a measure for emotional style. In this measure, Positive Emotional Style (PES) is characterized by three subcategories: vigor (*lively, full-of-pep, energetic*), well-being (*happy, pleased, cheerful*), and calm (*at ease, calm, relaxed*).

Is Positive Affect a Unique Concept?

Before addressing its health implications, it is important to ask whether PA is a unique concept. Though there has been some debate regarding the unique contributions of positive versus negative affect (c/f. Brenner, 1975; Diener & Emmons 1984), they have in fact emerged as highly distinctive dimensions that consistently emerge across various descriptor sets, time frames, response formats, languages and cultures (Watson et al., 1988). In fact, PA functions relatively independently from NA, particularly over longer periods of time as in stable traits versus mood states (e.g., Clark & Watson, 1991; Diener & Emmons, 1984). For instance, it has

been shown that NA is related to depression and anxiety whereas PA is negatively correlated with depression measures, but uncorrelated with anxiety measures (tripartite model: Clark & Watson, 1991b); this finding has been consistently replicated across various settings and populations (e.g., Cook, Orvaschel, Simco, Hersen, & Joiner, 2004; Kiernan, Laurent, Joiner, Catanzaro, & MacLachlan, 2002; Phillips, Lonigan, Driscoll, & Hooe, 2002; Teachman, Siedlecki, & Magee, 2007). Huppert and Whittington (2003) looked at mortality as related to positive versus negative well-being in a large sample and found that 7-year mortality was predicted more strongly by the absence of positive well-being than by the presence of negative well-being. Similarly, in a study of depression as a mortality predictor in the elderly, Blazer and Hybels (2004) found that scoring lower on PA was more predictive of mortality than scoring higher on NA. In addition, recent research on affect and neuroendocrine and cardiovascular functions found a significant difference between biomarkers associated with positive versus negative affect (Ryff et al., 2006). Cohen and colleagues (2003) demonstrated that after controlling for NA, PA predicted unique variance in resilience to infection. Interestingly, psychological well-being shows a more pervasive and distinct biological signature than psychological ill-being. Finally, recent evidence from our lab indicates that PANAS-X derived trait PA and NA can be differentiated in both interpersonal space and the five-factor model (Terrill & Ruiz, in progress). These findings suggest that PA and NA are related yet distinct concepts as opposed to flip-sides of the same coin.

Within the field of positive psychology there are numerous factors that may converge with the concept of PA. For example, subjective well-being is a related construct comprised of affective and cognitive or evaluative components, namely happiness, PA, and life satisfaction (Diener, 1984). Life satisfaction, a cognitive or evaluative component, has been shown to be

positively related to but separate from PA (Lucas, Diener, & Suh, 1996). Similarly, optimism, a cognitive trait, is generally positively associated with PA (Ben-Zur, 2003); however, several studies have determined that optimism is separable from other measures of well-being, including PA (Carver et al., 1993; Lucas et al., 1996). Psychobiologically, PA has recently been shown to have different effects on diurnal salivary cortisol levels than optimism (Lai et al., 2005). This literature demonstrates that though related, PA is distinct from other factors in positive psychology research.

Positive Affect and Health

A recent literature review (Pressman & Cohen, 2005) found consistent patterns in the relationship between DPA and physical health outcomes. Evidence from the review suggests an association of DPA and lower morbidity (c/f Middleton & Byrd, 1996; Ostir, Markides, Peek, & Goodwin, 2001), decreased symptoms and pain (c/f Cohen et al., 2003; Grootscholten et al., 2003), as well as increased longevity (c/f Kawamoto & Doi, 2002; Ostir, Markides, Black, & Goodwin, 2000). For example, in a 20-year community sample study of initially healthy Finnish adults, lower life satisfaction (comprised of interest in life and happiness, which are considered components of PA) was associated with higher mortality attributable to disease, injury, and suicides, even after adjusting for age, marital status, social class, smoking and alcohol status (Koivumaa-Honkanen et al., 2001). Another, rather unique study that coded autobiographies of nuns in their early 20s for emotion words found a significant relationship between the number of positive emotion words and education-adjusted mortality assessed 60 years later (Danner, Snowdon, & Friesen, 2001).

Stress-related physiological reactivity may be one possible pathway linking PA to health. The reactivity hypothesis suggests that larger, more frequent, and longer lasting physiological changes such as increased blood pressure may contribute to the development and progression of stress-mediated disease (Kamarck & Lovallo, 2003; Krantz & Manuck, 1984; Manuck, 1994). Cardiovascular, immune and endocrine reactivities are interrelated in a unified physiological stress response (Cohen et al., 2000). Positive affect may buffer against such reactivity by reducing the frequency of stressful experiences, moderating the magnitude of the stress experience and associated physiological response, as well as shortening the duration of recovery.

Growing evidence supports an inverse relationship between higher PA and lower levels of stress hormones including cortisol, epinephrine, and norepinephrine (Cohen et al., 2003; Polk, Cohen, Doyle, Skoner, & Kirschbaum, 2005; Smyth et al., 1998; Stone, Cox, Valdimarsdottir, Jandorf, & Neale, 1987). Positive affect is also associated with individual differences in immune functioning. In a series of studies, Cohen and colleagues (2003) found that higher positive emotions were associated with a greater resistance to developing a common cold in participants who were exposed to one of two types of rhinoviruses. This association was true for all of the component subscales (vigor, calm, well-being), which suggests the observed effect is a reflection of the role of positive emotionality as opposed to any specific positive emotion. In addition to greater resistance to disease, higher PA is also associated with faster response to infection. For example, Marsland and colleagues (2006) demonstrated that participants high in PA mounted a higher antibody response (i.e., seroconversion) to hepatitis B vaccinations than individuals lower in PA. Similar findings were reported in a study using hepatitis A and influenza vaccinations (Hayney et al., 2003). Thus, recent research supports PA as a moderator of resistance and response rate to infection.

Relatively few studies have investigated the relationship between PA and cardiovascular reactivity (CVR: blood pressure & heart rate). Based on the conception that positive emotions such as happiness function as "undoers" of autonomic nervous system arousal produced by certain negative emotions (Fredrickson & Levenson, 1998), Tugade and Fredrickson (2004) found that experiencing positive emotions reduced the cardiovascular recovery time after a negative emotional stressor in trait resilient participants. They proposed that certain individuals are more likely to draw on positive emotions during stressful situations, intuitively drawing on the "undoing effect" that positive emotions appear to have on psychological and physiological stress, thereby enhancing coping resources (Tugade et al., 2004). Whereas the aforementioned research focused on state positive affect, Steptoe and colleagues used an aggregate of momentary assessments of happiness to study the effects of trait-like positive affect. As part of the Whitehall psychobiology study, Steptoe, Wardle and Marmot (2005) attempted to assess cardiovascular, neuroendocrine, and inflammatory markers during a laboratory stress-task and using ambulatory monitoring. They were unable to replicate the faster post-stress cardiovascular recovery in the laboratory with participants high in PA; however, heart rate was inversely related to happiness by using ambulatory monitoring methods, as was cortisol output over the course of the day. Interestingly, in the three year follow-up, a significant inverse relationship between systolic blood pressure and happiness emerged as a new effect not present in the initial assessment (Steptoe & Wardle, 2005). In a later laboratory induced-stressor study, Steptoe and colleagues (2007) found a more rapid diastolic blood pressure recovery post-stress in individuals high in PA, as well as lower systolic pressure throughout the stress session.

As evidenced by current literature, there is support for high DPA as a health-protective factor. However, of the handful of empirical studies that have investigated possible mechanisms

for how DPA functions in a health-protective manner, the results have been mixed in terms of stress reactivity outcomes. Prior research in the field of personality traits and health suggests that the nature of the stressor plays an important role in cardiovascular reactivity (Smith, Glazer et al., 2004). For example, persons high in hostility show greater CVR during social stressor tasks than persons low in hostility; however, this difference becomes much smaller when the stressor is non-social in nature (Smith, 1992; Smith & Gallo, 2001). The current study followed a similar approach to determine whether DPA has a protective effect. We assessed cardiovascular reactivity and recovery in response to a social and a non-social laboratory stressor as related to DPA to examine a potential mechanism in DPA and health outcome.

CHAPTER TWO

METHODS

Participants

Ninety undergraduate students (44 women, 46 men) were recruited through the WSU Psychology Department's participant pool. The participants were between 18 and 30 years old; the mean age of the sample was 20.4 years (*SD* = 2.4). The majority of the sample identified themselves as Caucasian (71.1%) with the remainder self-identifying as Asian/Pacific Islander (11.1%), African-American (6.7%), Hispanic/Latino (5.6%), Native American (1.1%), and other (4.4%). All participants received 2 hours of course credit for participating in the laboratory session.

Procedure

Sessions were conducted in two adjoining rooms with designated participant chamber space and a second room for monitoring equipment. Except for brief interactions with the experimenter, participants were alone. Following initial informed consent, participants completed a demographics questionnaire and a modified 68-item version of the PANAS-X (Cohen et al., 2003; Watson & Clark, 1994). A blood pressure (BP) cuff was placed on the upper portion of the non-dominant arm (participants were first asked about handedness) to ensure that it would not interfere with the participants' ability to complete tasks and fill out questionnaires during the study. All participants first completed a minimally involving task or "vanilla" baseline (Jennings, Kamarck, Stewart, & Eddy, 1992). During the vanilla baseline, participants were asked to examine and rate their preference among paired sets of pictures of scenery. Ten sets of pictures were ranked at one-minute intervals (10-minute baseline). Physiological data were

collected for the final three minutes of the baseline. The purpose of the baseline was to obtain physiological data while participants were in a relaxed state that could then be compared to their physiological data obtained while performing a specified task and during recovery. At the completion of the baseline, participants completed a state affect measure for the first time.

Following the baseline, participants engaged in one of two counterbalanced tasks. Because we were interested in whether the social vs. non-social nature of the task distinguishes stress responses as related to DPA, participants completed each type of task. The non-social task consisted of a foot-immersion cold pressor. Audio-taped instructions introduced the cold pressor task. A five gallon bucket containing a mix of ice and water chilled to four degrees Celsius was used. Participants were instructed to immerse their left foot into the mixture such that the sole of their foot was flat on the bottom of the bucket. The task ran for three minutes during which BP was sampled at one minute intervals. At the conclusion of the task, participants completed a measure of subjective stressfulness of the task and the state affect measure for the second time and then were asked to sit quietly for ten minutes while recovery was assessed. Blood pressure was sampled at every other minute during recovery. Upon completion of recovery, participants were asked to complete the state affect measure for the third time.

A second baseline followed the first task that was intended to assure recovery from the first task and a return to basal status prior to beginning the second task. The same procedure used in the first baseline was applied, although the pictures were different. The participants also filled out a fourth state affect measure after the second baseline.

The second task was a social stressor in which participants were asked to prepare a speech that would be videotaped. The disclosure task involved identifying an embarrassing event, which participants described and mentally rehearsed, and finally, verbally disclosed into a

video camera. First, participants were asked to write a description of their three most embarrassing moments and to rate them on a scale of 1 (not at all embarrassing) to 10 (extremely embarrassing). An embarrassing moment was used as the speech topic because it is stressful and personally relevant. The experimenter chose the scenario that participants rated as most embarrassing. Guided recall, which involved audio-taped prompts, was used to help participants recall the experience and induce emotion prior to giving the speech (Smith, Ruiz, & Uchino, 2004). The prompts were spaced 45 seconds apart and asked participants (1) to write the basic description of the event, (2) to describe thoughts and emotions they experienced during the event, (3) to describe how they coped with the event, (4) whether they told anyone of the event and how that person responded, and (5) how thinking about the event makes them feel now. After writing, the audio-taped prompts guided participants to rehearse the events for a three minute period, during which time BP measurements were taken at one minute intervals. Participants filled out a fifth state affect measure after the mental rehearsal period. Lastly, the participants were asked to describe their most embarrassing moment directly to a video camera. The audio-taped prompts guided the participants through each of the five aspects of the event at one minute intervals for the total five minute speech. Blood pressure was sampled at every other minute. At the conclusion of the disclosure task, participants filled out a second measure of subjective stressfulness of the task and a sixth state affect measure and then were asked to sit quietly for ten minutes while recovery was assessed. Blood pressure measurements were taken every other minute during recovery. Upon completion of recovery, participants completed the state affect measure for the final time. Participants were then debriefed at the conclusion of the laboratory session as to the deceptive component of the disclosure task, i.e. no video was actually recorded.

Measures

Positive and Negative Affect Schedule – Extended Version (PANAS-X). The PANAS-X (Watson & Clark, 1994) is a 60-item self-report instrument asking the participant to rate how strongly they "generally" feel each item based on a 5-point Likert-type scale (1 = lowest, 5 = highest). The PANAS-X is an alternate version of the PANAS (Watson, Clark, & Tellegen, 1988) that is designed to measure PA and NA as well as some additional affective states, such as *serenity, fatigue*, and *surprise*. The PANAS-X was chosen, because it is a psychometrically sound and widely used instrument.

Cohen's Positive and Negative Emotional Styles (PES/NES). Cohen and colleagues (2003) created this variant of the PANAS-X to measure emotional styles. Items from this measure were used in addition to the PANAS-X.

Mood and state affect. Following each baseline, cold pressor task, disclosure task, and recovery periods, participants completed a questionnaire consisting of sixteen 4-point Likert items assessing current affect state. Twelve items reflecting anger and anxiety (Jennings et al., 1992), included the following: Six items (four negatively valenced: w*orried, tense, nervous, anxious*; two positively valenced: c*alm, relaxed*) were drawn from the state anxiety subscale of the Spielberger State-Trait Personality Inventory (STPI; Spielberger, 1979). Four negatively valenced items (*annoyed, angry, irritated, aggravated*) were taken from the STPI state anger subscale. Because the original STPI anger scale lacked positively valenced items, two (*friendly, kindhearted*) were added to provide greater balance (Smith et al, 2004). To assess for presence of positive state affect, four additional items (*I feel happy, I feel joyful, I am delighted, I feel cheerful*) were taken from the joviality subscale on the PANAS-X (Watson & Clark, 1994). This state affect measure was administered a total of seven times during the session: After each

baseline, after the cold pressor task, after mental rehearsal and speech during the disclosure task, and following each recovery.

Measure of subjective stressfulness. A measure to assess subjective stressfulness of task (*How stressful was this task?*) on a 7-point Likert type scale was administered after completion of the cold pressor task and after the disclosure task.

Physiological Data. A Dinamap Pro 100 monitor (GE Medical, Miami, FL) was used to collect systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and heart rate (HR) measurements. The Dinamap Pro 100 uses the non-invasive oscillometric method to obtain these physiological measures. A BP cuff, fitted with an electronic pulse sensor that detects blood flow, is placed on participants' non-dominant upper arm. As the cuff is inflated via an electric pump and valve, it compresses the artery and no pulsations are perceived by the device. As the pressure in the cuff decreases, the artery starts to emit pulsations in synchrony with the cyclic expansion and contraction of the brachial artery, i.e. it will oscillate. The pressure then measured on the device defines the systolic blood pressure (SBP), which is the peak blood pressure in the arteries. As the pressure in the cuff decreases, the oscillations will become increasingly significant, until a maximum amplitude of these oscillations defines the average blood pressure, or mean arterial pressure (MAP). The diastolic blood pressure (DBP) is the lowest pressure in the arteries and is measured as the cuff further deflates and the oscillations disappear. The Dinamap Pro 100 then does not directly measure BP, but uses an algorithm based on oscillations to produce a numerical readout of BP measurements.

Data Analysis

Differences in measures of cardiovascular reactivity (SBP, DBP, MAP, HR) and affect were analyzed across cold pressor task, mental rehearsal, speech portion of disclosure task, and both recovery periods. Change scores (i.e., task minus baseline) were calculated for each sampled measure of each task period as per prior recommendations (Llabre, Spitzer, Saab, Ironson, & Schneiderman, 1991). Data were analyzed using multiple linear regression analyses for DPA, DNA and SBP, DBP, MAP, HR, and state affect. Baseline values were included as a covariate because baseline levels can impact degree of change (Benjamin, 1967). Also, repeated measures mixed analyses of covariance (ANCOVAs) were used to compare SBP, DBP, MAP, HR, and state affect in the disclosure versus cold pressor tasks and disclosure recovery versus cold pressor recovery. Again, baseline values were included as a covariate.

Hypothesis 1: Expect main effect for sex: Men's CVR > women's CVR.

Hypothesis 2: Expect baseline equivalency.

Hypothesis 3: Expect no differences in CVR or CVR recovery for participants with higher DPA during the non-social cold pressor task based on reviewed literature on DPA and hostility.

Hypothesis 4: Expect lower CVR and faster CVR recovery for participants with higher DPA during the social task (mental rehearsal, disclosure, and recovery).

Hypothesis 5: Expect no state affect differences for the cold pressor task or recovery.

Hypothesis 6: Expect less negative state affect among higher DPA participants for the social task or recovery.

CHAPTER THREE

RESULTS

Baseline Equivalence

Baseline equivalences of groups were tested using independent samples t-tests with sex as grouping variable. Systolic blood pressure and MAP were significantly higher in men than women for both cold pressor baseline and disclosure baseline (see Table 1). All other baseline physiological indices and state affect measures were statistically equivalent in men and women, ts(87) < 1.82, p = ns.

Paired samples t-tests were used to determine overall baseline equivalences between cold pressor and disclosure tasks. Results revealed that the two baselines did not differ on any physiological or affective measure, all ts(88) < 1.84, p = ns (see Tables 2 and 3). Thus, participants were equal in terms of measured variables prior to beginning each task.

Task Effectiveness

Cold Pressor Task. Significant time effects were found for all physiological measures from baseline to cold pressor task to recovery, all Fs(2, 174) > 94.46, p < .001, η^2 > .520 (see Figure 1). Paired samples t-tests revealed that all physiological indices rose significantly from baseline to task and decreased significantly from task to recovery, though remained significantly elevated over baseline, all ts(88) > 2.25, p < .05 (see Table 2). Significant time effects were also found for all affect measures from baseline to cold pressor task to recovery, all Fs(2, 174) > 18.95, p < .001, η^2 > .175 (see Figure 2). Paired samples t-tests revealed that anxiety and anger both rose significantly from baseline to task and decreased significantly from task to recovery (all ts(88) > 6.70, p < .001), but anxiety during recovery dropped significantly below baseline,

$t(88) = 4.35$, $p < .001$, whereas anger returned to baseline level, $t(88) = 1.25$, $p = .215$. Happiness decreased significantly from baseline to task and rose significantly from task to recovery, ts(88) > 4.25, $p < .001$, returning to baseline level, $t(88) = 1.53$, $p = .130$.

Disclosure Task. Significant time effects were found for all physiological measures from baseline to mental rehearsal to disclosure to recovery, all Fs(3, 264) > 56.34, $p < .001$, $\eta^2 > .389$ (see Figure 3). Paired samples t-tests revealed that all physiological indices rose significantly from baseline to mental rehearsal and again rose significantly to disclosure from which they decreased significantly to recovery, remaining significantly lower than mental rehearsal and significantly elevated over baseline, all ts(89) > 2.21, $p < .05$. Significant time effects were also found for all affect measures from baseline to mental rehearsal to disclosure and to recovery, all Fs(3, 261) > 14.77, $p < .001$, $\eta^2 > .144$ (see Figure 4). Paired samples t-tests showed that anxiety and anger rose significantly from baseline to mental rehearsal, ts(89) > 4.83, $p < .001$. Whereas anxiety significantly decreased from mental rehearsal to disclosure and again decreased from both tasks to recovery, dropping significantly below baseline, all ts(89) > 2.97, $p<.005$, anger during mental rehearsal did not significantly differ from anger during disclosure, $t(89) = 1.49$, $p = .140$, but then decreased significantly from both tasks to recovery, ts(89) > 3.64, $p<.001$, returning to baseline level, $t(89) = 1.37$, $p = .174$. Happiness decreased significantly from baseline to mental rehearsal and then significantly increased to disclosure and rose again from tasks to recovery, ts(89) > 3.01, $p<.004$, returning to baseline level, $t(89) = 1.46$, $p = .148$.

Task Stressfulness. Participants rated the stressfulness of the cold pressor and disclosure task immediately following each task. One-way ANOVA showed no significant sex differences in perceived stressfulness of either task, $F(1, 88) > 2.98$, $p =$ ns. However, paired samples t-test

revealed that participants found the cold pressor to be significantly more stressful than the disclosure task (4.2 vs. 3.6; $t(88) = 2.92$, $p < .006$ (2-tailed)).

Task Attrition. The cold pressor task is a well-documented aversive task. Eight of the 90 participants failed to complete the three minute trial. One-way ANOVA showed that those who did not complete the task did not significantly differ in terms of age, gender, or DPA or DNA from those who completed the cold pressor task, $F(1, 89) < 1.94$, p = ns.

Dispositional Positive Affect and Task Reactivity

Cold Pressor Task. Multiple regression analysis showed an effect for sex and HR for the cold pressor task. Women had a greater increase in HR during the cold pressor task, $B = 4.741 \pm 1.967$, $t = 2.410$, $p = .018$. No other sex effects were found for this task. Multiple regression analysis revealed a marginal effect for DPA and MAP, $B = -0.244 \pm 0.140$, $t = -1.739$, $p = .086$. Individuals lower in DPA had higher MAP. Also, a marginal interaction effect was found for sex and DPA and HR, $B = -0.534 \pm 0.305$, $t = -1.751$, $p = .084$ (see Figure 5). Specifically, women lower in DPA experienced higher HR during the cold pressor task, $B = -0.573 \pm 0.236$, $t = -2.422$, $p = .020$. No effects were found for SBP or DBP.

A significant effect was found for sex and SBP during the recovery of the cold pressor task. Specifically, men showed a greater change in SBP during cold pressor recovery, $B = -2.679 \pm 1.076$, $t = -2.489$, $p = .015$. No other sex effects were found for this task. Further, no significant main effects or interaction effects were found for DPA or DNA on any of the physiological measures for the cold pressor recovery period.

No significant sex main effects were found for change in affect during the cold pressor task. Multiple regression analysis revealed a main effect for DNA and anger, $B = 0.134 \pm 0.066$,

$t = 2.033$, $p = .045$. Individuals higher in DNA experienced more anger during the cold pressor task. Also, a marginal effect was found for DPA and anxiety, $B = -0.092 \pm 0.054$, $t = -1.699$, $p = .093$. Individuals lower in DPA experienced more anxiety during the cold pressor task. Multiple regression analysis also revealed an interaction effect for sex and DPA and happiness, $B = -0.254 \pm 0.111$, $t = -2.284$, $p = .025$; however, follow-up analysis did not show any significant effects for men or women.

No significant sex main effects or DPA or DNA main effects were found for any of the affect measures for the cold pressor recovery period.

Disclosure Task. For the mental rehearsal portion of the disclosure task, no sex main effects were found. Multiple regression analysis revealed a main effect for DNA and MAP, $B = 0.155 \pm 0.069$, $t = 2.236$, $p = .028$, and a marginal effect for DNA and SBP, $B = 0.739 \pm 0.443$, $t = 1.666$, $p = .099$. Individuals higher in DNA experienced greater increases in MAP and SBP during the mental rehearsal portion of the disclosure task. No effects were found for DBP or HR.

No sex main effects were found for the speech portion of the disclosure task. Multiple regression analysis revealed an interaction effect for sex and DNA and HR, $B = -0.674 \pm 0.319$, $t = -2.110$, $p = .038$ (see Figure 6). Specifically, men higher in DNA tended to have higher HR during disclosure, though this effect was marginal, $B = 0.371 \pm 0.196$, $t = -1.894$, $p = .065$. No effects were found for SBP, DBP, or MAP.

A marginal effect was found for sex and HR during recovery of the disclosure task. Women had a greater decrease in HR during disclosure recovery, $B = 1.690 \pm 0.971$, $t = 1.739$, $p = .086$. Multiple regression analyses revealed marginal effects for DPA and MAP, $B = -0.086 \pm 0.052$, $t = -1.651$, $p = .10$, and DPA and SBP, $B = -0.143 \pm 0.078$, $t = -1.829$, $p = .071$. Those

lower in DPA tended to have higher MAP and SBP, indicating a longer cardiovascular recovery period. No effects were found for DBP or HR.

No main sex effects were found for change in affect during the mental rehearsal portion of the disclosure task. Multiple regression analysis revealed main effects for DNA and anxiety, $B = 0.284 \pm 0.076$, $t = 3.745$, $p < .001$, and DNA and happiness, $B = -0.177 \pm 0.083$, $t = -2.137$, $p = .036$. Specifically, individuals higher in DNA experienced more anxiety and less happiness during the mental rehearsal portion of the disclosure task.

No main sex effects were found for change in affect during the speech portion of the disclosure task. Multiple regression analysis revealed a main effect for DNA and anxiety, $B = 0.236 \pm 0.088$, $t = 2.690$, $p = .009$, where individuals higher in DNA experienced greater anxiety. Multiple regression analysis also revealed an interaction effect for sex and DNA and happiness, $B = -0.346 \pm 0.164$, $t = -2.102$, $p = .039$ (see Figure 7). Women higher in DNA tended to experience less happiness during disclosure, $B = -0.308 \pm 0.13$, $t = -2.372$, $p = .023$. No effect was found for anger.

During recovery, no sex main effects were found for change in affect. Multiple regression analysis revealed a main effect for DNA and anxiety, $B = 0.165 \pm 0.048$, $t = 3.466$, $p = .001$, and a marginal effect for DNA and anger, $B = 0.072 \pm 0.04$, $t = 1.781$, $p = .079$. Individuals higher in DNA experienced more anxiety and anger. Similar to the speech portion of the disclosure task, multiple regression analysis also revealed a marginal interaction effect for sex and DNA and happiness, $B = -0.247 \pm 0.125$, $t = -1.975$, $p = .052$ (see Figure 8). Women higher in DNA experienced less happiness during disclosure recovery, $B = -0.200 \pm 0.086$, $t = -2.334$, $p = .025$.

Dispositional Positive Affect Differences to Social vs. Non-social Tasks

Paired samples t-tests revealed that DBP, MAP, and HR were significantly higher during the cold pressor task than during the disclosure task, all *t*s(88) > 2.12, $p < .038$; however, no significant difference in SBP was found between the tasks, $t(88) = .966$, p = ns. Paired samples t-tests for affect measures showed that anger was significantly higher ($t(88) = 3.889$, $p < .001$) and happiness significantly lower ($t(88) = 2.189$, $p = .031$) during the cold pressor task than during the disclosure task. No significant difference in anxiety was found between the tasks, $t(88) = 1.581$, $p = .118$.

ANCOVA analyses revealed no significant differences for DPA and within-subject physiological measures between the cold pressor task and the disclosure task or cold pressor recovery and disclosure recovery, all *F*s(1, 84) < 2.47, all *p*s = ns. No significant differences were found for DNA and within-subject physiological measures between the cold pressor task and the disclosure task or cold pressor recovery and disclosure recovery, all *F*s(1, 83) < 1.83, all *p*s = ns. ANCOVA analyses revealed significant differences for DPA and increase in anxiety during the cold pressor task and the disclosure task, $F(1, 84) = 5.590$, $p = .020$, and cold pressor recovery and disclosure recovery, $F(1, 83) = 5.006$, $p = .028$. Specifically, DPA was associated with a greater increase in anxiety during the disclosure task and recovery than during the cold pressor task and recovery. A marginal difference was found for DNA and change in anxiety between cold pressor and disclosure recovery, $F(1, 83) = 3.090$, $p = .082$. Dispositional negative affect was associated with higher levels of anxiety during the disclosure recovery than during the cold pressor recovery. No other significant differences were found for DPA or DNA on within-subject state affect measures between cold pressor and disclosure tasks or cold pressor and disclosure recovery.

CHAPTER 4

DISCUSSION

Baselines for physiological and state affect measures were expected to be equivalent for both the cold pressor and disclosure tasks (hypothesis 2). Results revealed that overall the two baselines did not differ on any physiological or affective measures, indicating that participants began both tasks at equal levels in terms of measured variables and any changes in cardiovascular and state affect measures could be attributed to the tasks. Men and women were statistically equivalent on all state affect measures and all but two physiological measures. Men had significantly higher SBP and MAP at baseline as compared to women. Overall, analyses indicate that the tasks were effective in producing significant physiological responses and changes in state affect.

Based on prior findings supporting hostility as a moderator of CVR to social but not non-social lab stressors, individuals with higher DPA were expected to have significantly lower CVR and faster CVR recovery for the disclosure (social) task but not for the cold pressor (non-social) task (hypothesis 4). Contrary to expectations, DNA seemed to have an effect on CVR during the mental rehearsal and speech portions of the disclosure task. Specifically, individuals higher in DNA showed greater increases in SBP and MAP during mental rehearsal. Only men higher in DNA tended to have higher HR during the speech portion of the disclosure task. Though DPA was not found to have a significant effect on physiological measures during the mental rehearsal and speech portions of the disclosure task, it did seem to affect cardiovascular recovery. Specifically, individuals higher in DPA showed decreased MAP and SBP, indicating a shorter cardiovascular recovery period following the disclosure task. Individuals higher in DPA were expected to have less state negative affect during the disclosure task than individuals lower in

DPA (hypothesis 6). Similar to findings for physiological measures, again it seemed to be DNA that had a significant bearing on the participant's change in state affect. In general, individuals higher in DNA experienced greater anxiety and anger during all portions of the disclosure task. Happiness was negatively affected by higher levels of DNA for all individuals during the mental rehearsal portion of the task; however, during disclosure and recovery, only women higher in DNA were less happy. These findings suggest that during a social stressor, individuals higher in DNA may experience greater CVR, whereas individuals higher in DPA may be able to more quickly recover following a social stressor. State affect during the disclosure task appeared to be influenced by DNA rather than DPA; therefore, individuals higher in DNA are more likely to experience more anger and anxiety (or higher levels of state negative affect) during and when recovering from social stressors. Interestingly, women higher in DNA experienced less state positive affect during the social stressor than men.

In contrast to the disclosure (social) task, DPA was expected to have no significant impact on individuals' CVR, recovery, and state affect during the cold pressor (non-social) task (hypotheses 3&5). However, during the cold pressor task, higher DPA was associated with lower HR in women and lower MAP in all individuals. Compared to state affect during the disclosure task, individuals higher in DNA experienced more anger during the cold pressor, but higher anxiety seemed to be affected by lower levels of DPA. Also, a sex interaction effect was found for DPA and happiness, but follow-up analyses were unable to determine which sex's happiness was affected by DPA. These findings suggest that during non-social stressors, higher levels of DPA may reduce the intensity of particular CVR markers as well as anxiety; however, in contrast to the social stressor, DPA did not appear to influence recovery from a non-social stressor.

This experiment contributes to the literature in several important ways. First, findings on the effects of DNA on physiological measures and anger and anxiety support research in existing literature (Suls & Bunde, 2005). An elaboration on this finding is that DNA seemed to have a more significant impact on CVR during the social stressor task (disclosure) than the non-social stressor task (cold pressor). This is similar to findings reported on prior research on hostility (Smith, 1992; Smith & Gallo, 2001), which suggests that the effect of DNA on CVR may be influenced by the social nature of the task. Existing research is limited with respect to potential mechanisms for the beneficial effect of DPA noted in the literature. The results of this experiment broaden the understanding of dispositional cardiovascular differences as related to different levels of DPA in individuals. Specifically, prior research findings (Fredrickson & Levenson, 1998; Tugade & Fredrickson, 2004) suggest that experiencing positive emotions facilitated faster cardiovascular recovery after an emotional stressor in women. The current experiment supported this finding (and extended it to include both sexes) in that male and female participants higher in DPA demonstrated faster MAP and SBP recovery from the disclosure task. However, individuals in this experiment were not necessarily experiencing more positive emotions during the disclosure task, which suggests that dispositional positive affect rather than state positive affect influenced the cardiovascular recovery rate.

Qualifications and Limitations

Because this experiment was conducted in a laboratory setting on college students, the generalizability of the findings is limited. It could be argued that the artificial nature of the laboratory affected cardiovascular functioning differently than what would be observed in a more natural setting. Similarly, because the participants were healthy, relatively young, predominantly

Caucasian adults, findings are limited to this particular population, and may differ in persons of different races and/or ethnicities, age groups, and overall health status. Finally, even though the measures used in this experiment were selected for their sound psychometric properties and widely accepted use, different measures may produce different findings. Future research should address these issues accordingly.

Conclusions

In spite of these limitations, the findings in this research help broaden our understanding of one potential mechanism for the beneficial effects of dispositional positive affect described in existing literature. Specifically, dispositional positive affect may play a role in faster cardiovascular recovery following a social stressor, thereby protecting against the potentially damaging effects that a prolonged physiological response exerts on the cardiovascular system. This experiment represents one step in taking folklore about the health benefits of trait happiness toward fact.

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Table 1: Task baselines for physiological and affect measures

	Men	Women	t	df
Baseline Cold Pressor SBP	114.60 (9.60)	105.30 (7.90)	4.99***	87
Baseline Cold Pressor DBP	65.69 (5.52)	66.92 (6.36)	0.97	87
Baseline Cold Pressor MAP	85.14 (4.70)	82.47 (5.30)	2.52*	87
Baseline Cold Pressor HR	69.24 (9.18)	72.91 (9.97)	1.81	87
Baseline Disclosure SBP	115.75 (9.25)	104.23 (7.06)	6.62***	88
Baseline Disclosure DBP	65.20 (4.01)	65.70 (5.26)	0.51	88
Baseline Disclosure MAP	85.38 (3.72)	81.77 (4.09)	4.40***	88
Baseline Disclosure HR	69.71 (8.90)	72.52 (10.55)	1.37	88
Baseline Cold Pressor Anger	8.58 (1.89)	9.23 (3.10)	1.20	87
Baseline Cold Pressor Anxiety	9.38 (2.93)	9.34 (2.98)	0.06	87
Baseline Cold Pressor Happiness	15.76 (4.12)	15.66 (5.40)	0.10	87
Baseline Disclosure Anger	8.70 (1.82)	8.84 (2.79)	0.29	88
Baseline Disclosure Anxiety	8.87 (2.26)	9.34 (2.59)	0.92	88
Baseline Disclosure Happiness	15.59 (4.19)	16.45 (4.80)	0.91	88

Table 2: Means and standard deviations for physiological and affect measures for the cold pressor task.

	Baseline	Cold Pressor	Recovery
Physiological Measures			
SBP (mm/Hg)	114.64 (0.93)	126.49 (1.45)	113.48 (0.94)
DBP (mm/Hg)	66.30 (0.63)	78.29 (0.98)	67.27 (0.60)
MAP (mm/Hg)	83.81 (0.53)	95.33 (0.96)	85.54 (0.47)
HR (bpm)	71.07 (1.02)	79.27 (1.37)	68.44 (1.05)
Affect Measures			
Anger	8.90 (0.27)	11.29 (0.41)	9.13 (0.28)
Anxiety	9.36 (0.31)	11.98 (0.37)	8.31 (0.24)
Happiness	15.71 (0.51)	13.77 (0.51)	15.36 (0.50)

Table 3: Means and standard deviations for physiological and affect measures for the disclosure task.

	Baseline	Mental Rehearsal	Disclosure	Recovery
Physiological Measures				
SBP (mm/Hg)	109.99 (0.87)	115.92 (1.03)	125.17 (1.06)	112.74 (0.91)
DBP (mm/Hg)	65.45 (0.49)	69.69 (0.57)	75.50 (0.76)	67.75 (0.62)
MAP (mm/Hg)	83.58 (0.41)	87.27 (0.51)	93.04 (0.68)	85.59 (0.51)
HR (bpm)	71.11 (1.03)	73.38 (1.13)	77.35 (1.18)	70.05 (1.09)
Affect Measures				
Anger	8.78 (0.25)	10.30 (0.35)	9.92 (0.33)	9.03 (0.29)
Anxiety	9.12 (0.26)	12.39 (0.41)	11.31 (0.43)	8.28 (0.26)
Happiness	16.04 (0.48)	13.91 (0.52)	14.63 (0.52)	15.59 (0.48)

FIGURE CAPTION

Figure 1: Cold pressor task effects for physiological measures.

Figure 2: Cold pressor task effects for affect measures.

Figure 3: Disclosure task effects for physiological measures.

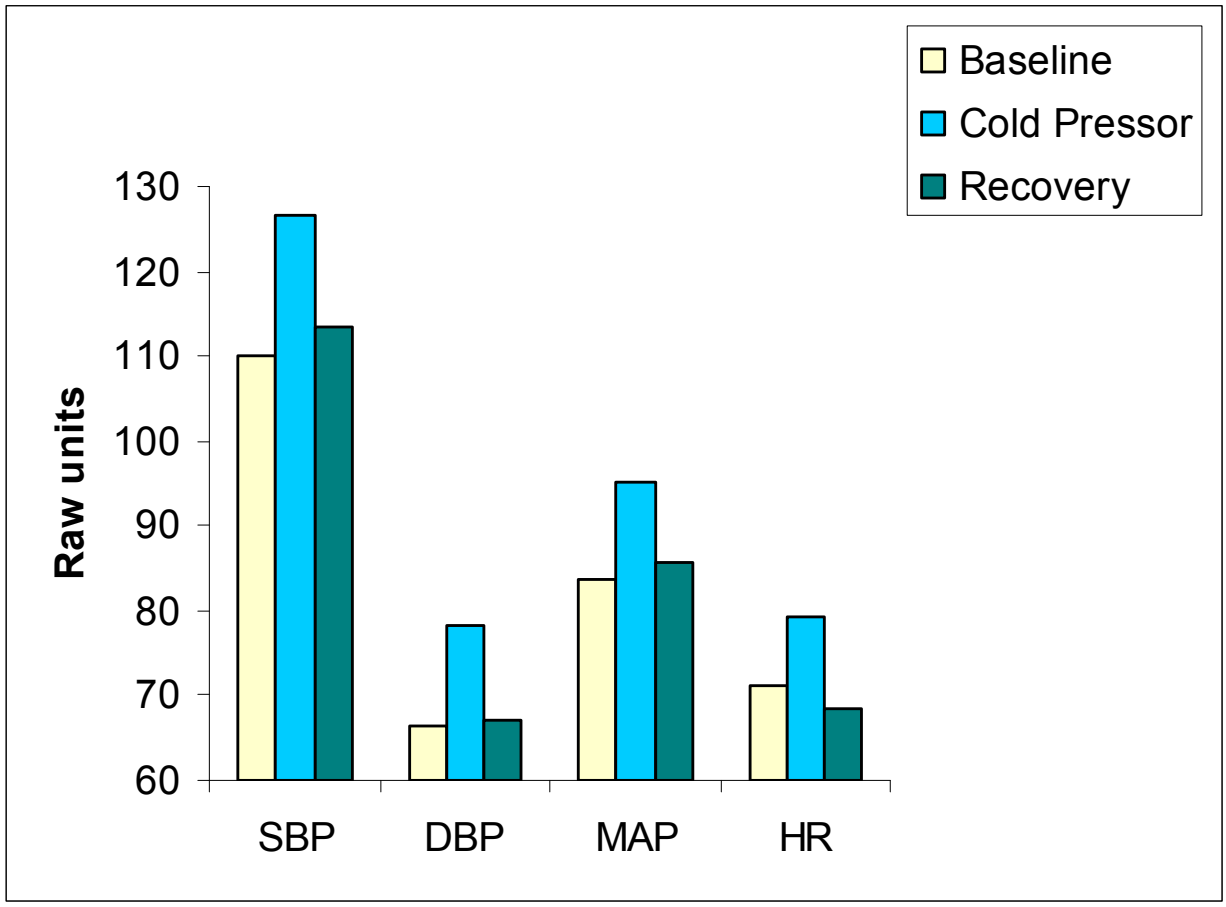
Figure 4: Disclosure task effects for affect measures.

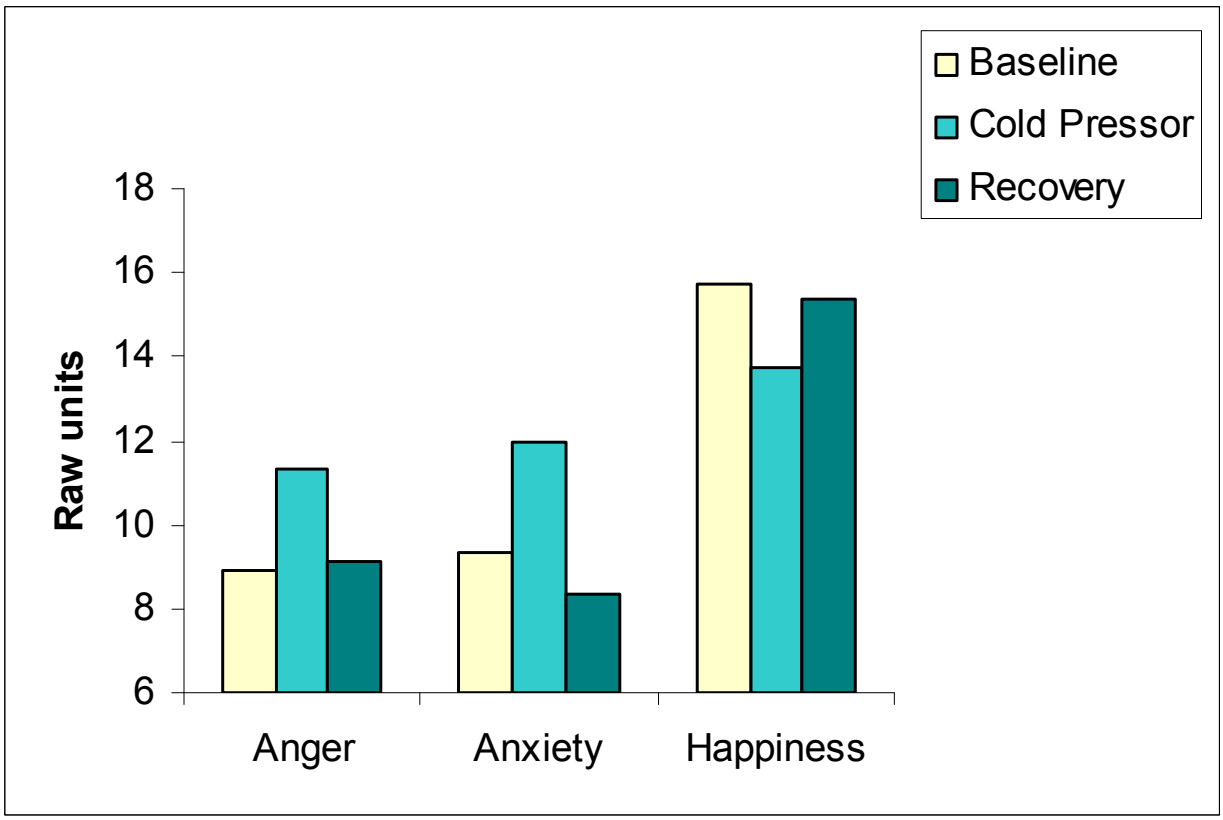
Figure 5: Sex x dispositional positive affect interaction effect for heart rate during the cold pressor task.

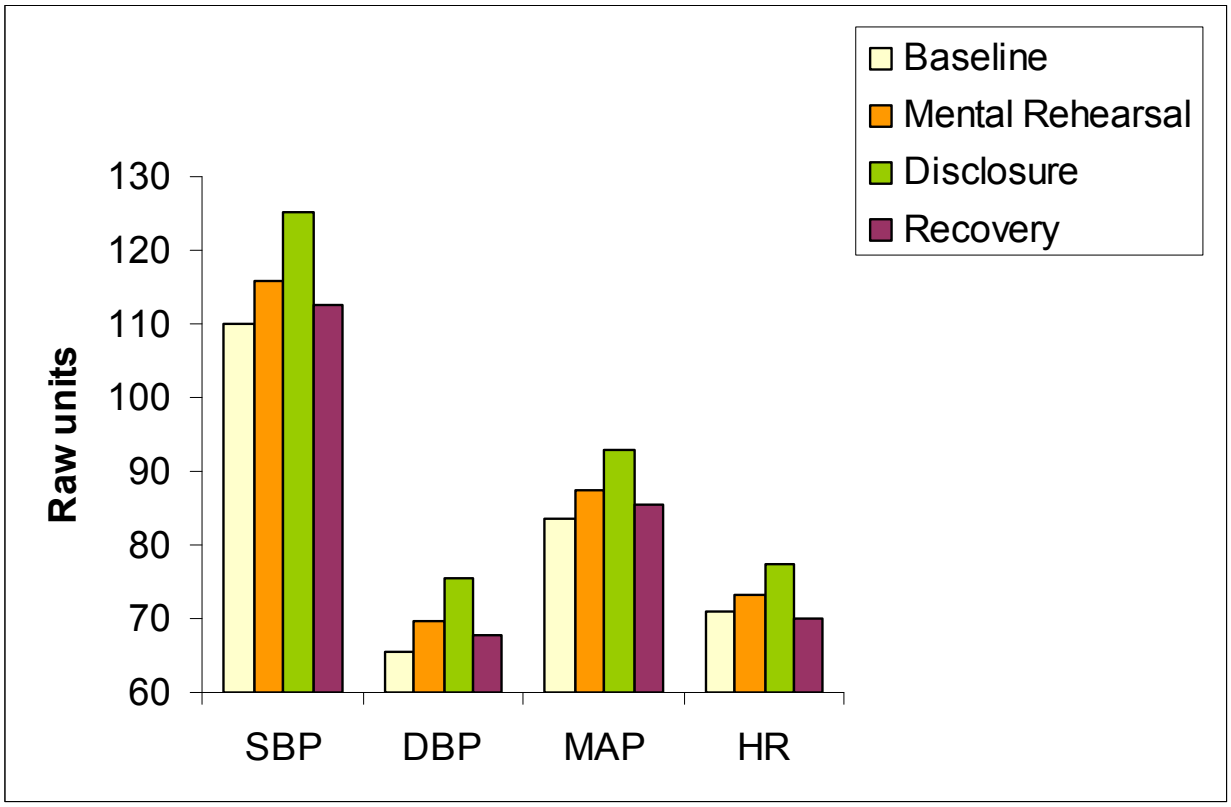
Figure 6: Sex x dispositional negative affect interaction effect for heart rate during the disclosure task.

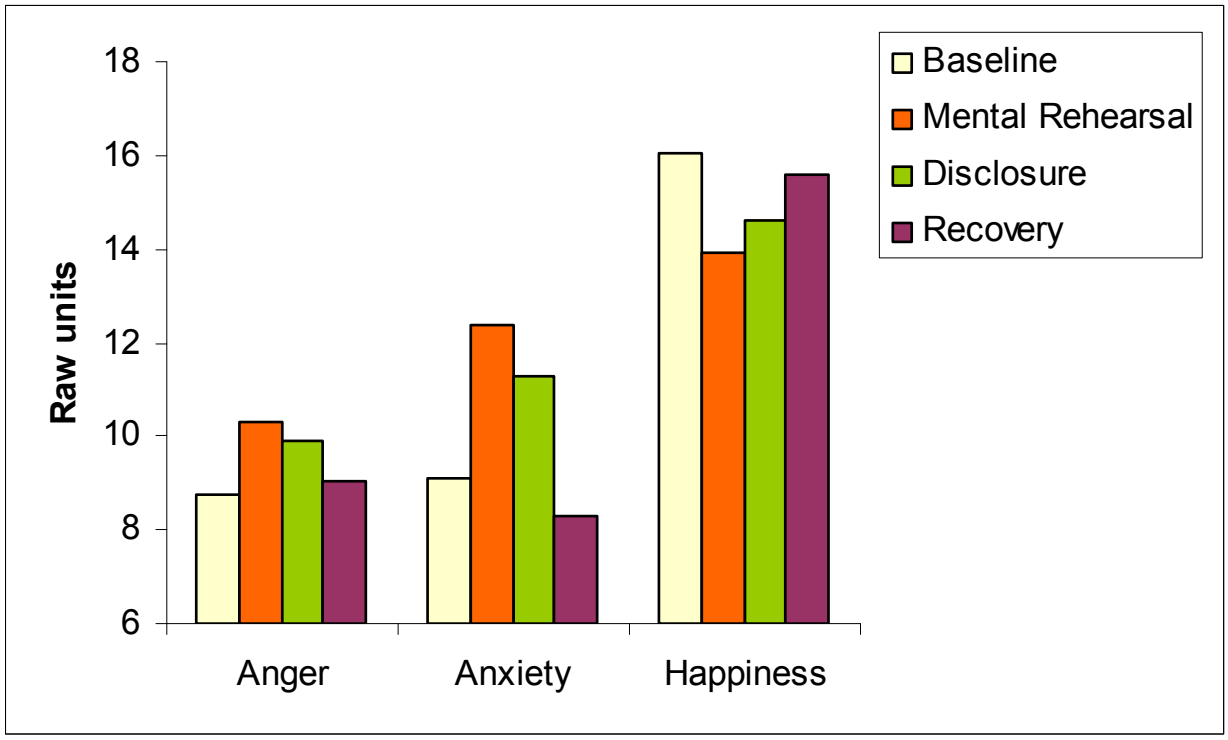
Figure 7: Sex x dispositional negative affect interaction effect for happiness during the disclosure task.

Figure 8: Sex x dispositional negative affect interaction effect for happiness during the recovery of disclosure task.


Baseline
Cold Pressor
Recovery
Raw units
130
120
110
100
90
80
70
60
SBP
DBP
MAP
HR


Baseline
Cold Pressor
Recovery
Raw units
18
16
14
12
10
8
6
Anger
Anxiety
Happiness


Baseline
Mental Rehearsal
Disclosure
Recovery
Raw units
130
120
110
100
90
80
70
60
SBP
DBP
MAP
HR


Raw units
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16
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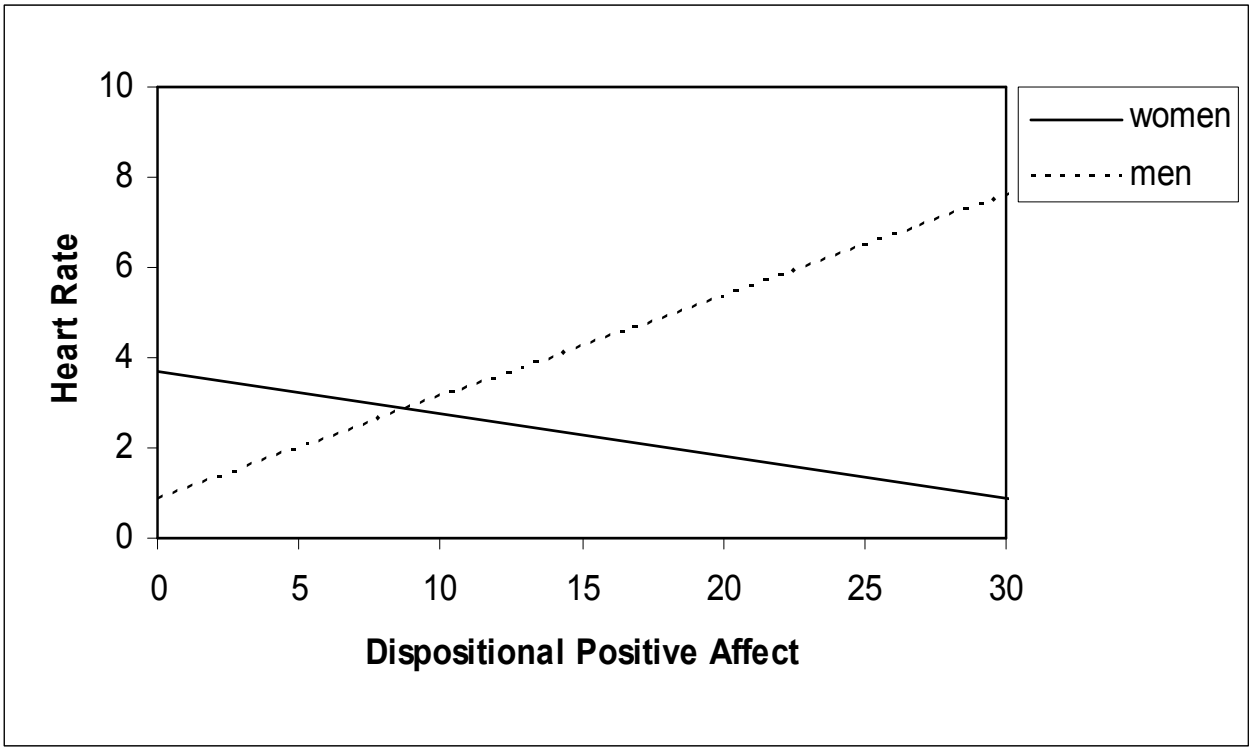
Anger
Anxiety
Happiness
Baseline
Mental Rehearsal
Disclosure
Recovery


10
8
6
4
2
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Heart Rate
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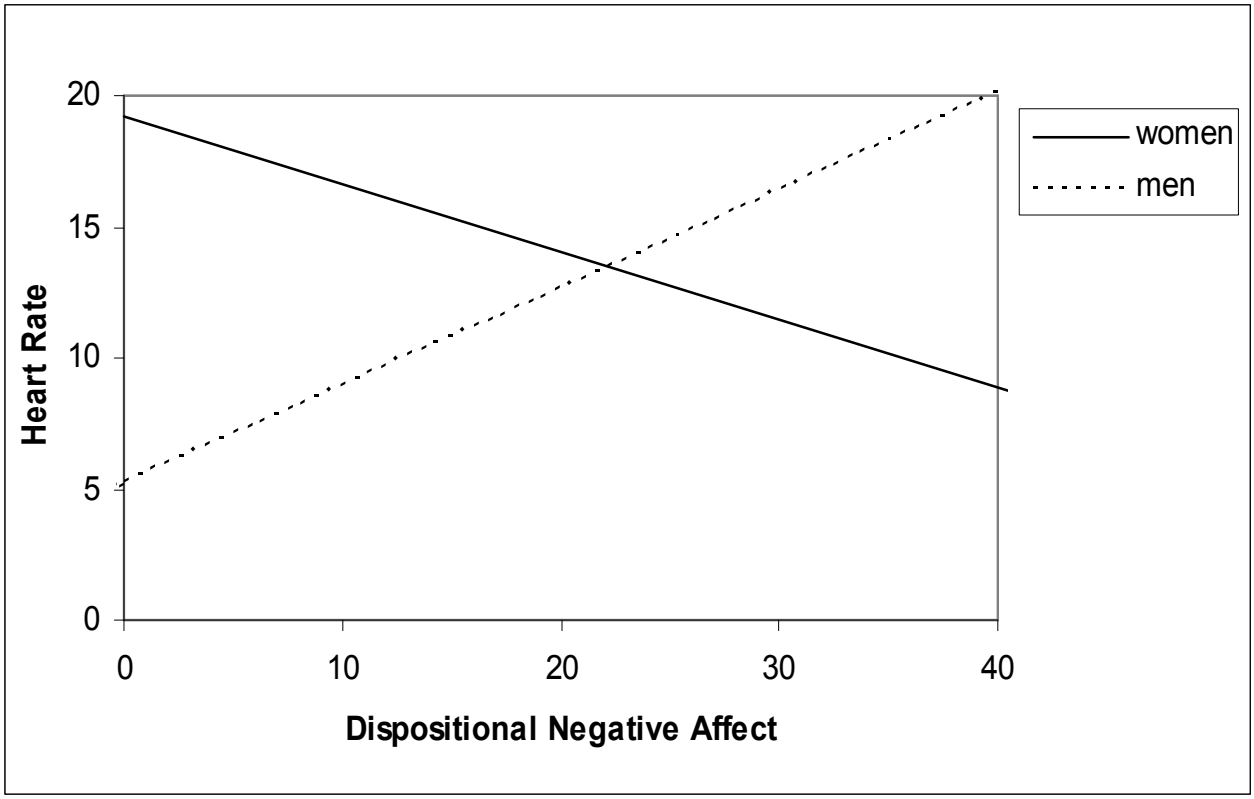
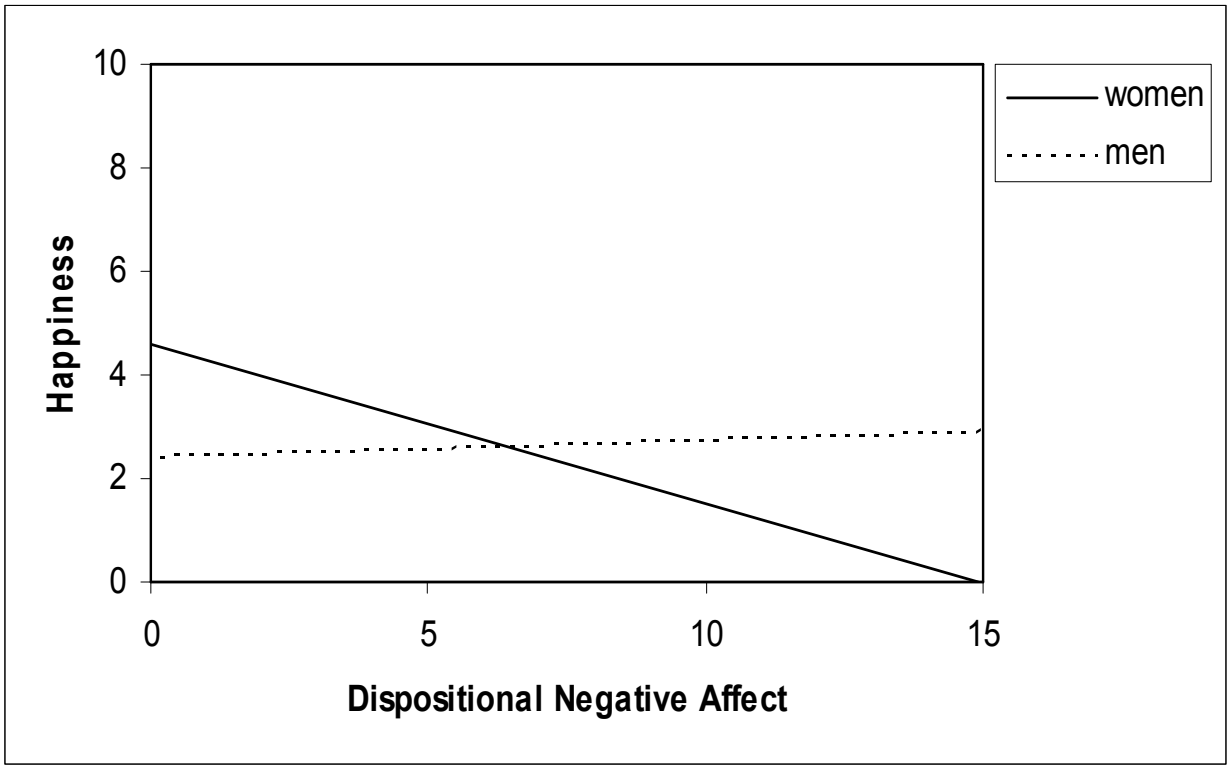
5
10
15
20
25
30
Dispositional Positive Affect
women
men


20
15
10
5
0
Heart Rate
0
10
20
30
40
Dispositional Negative Affect
women
men


10
8
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4
2
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Happiness
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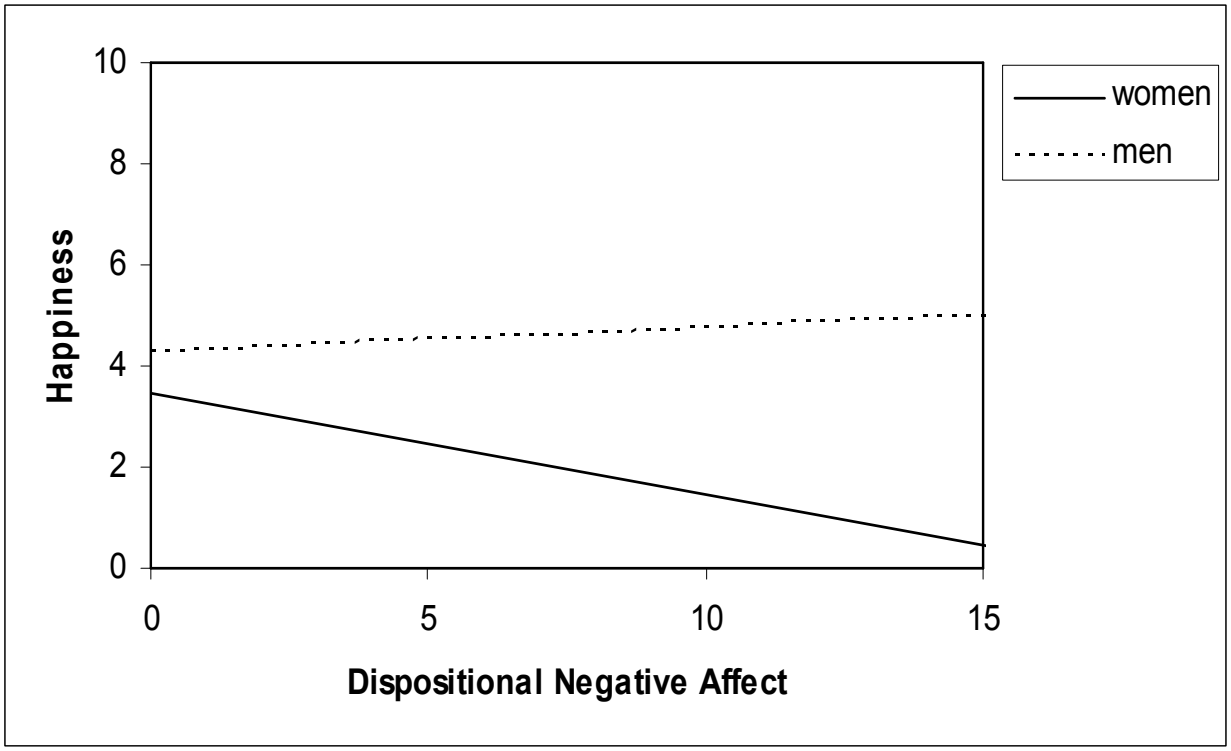
15
Dispositional Negative Affect
women
men


10
8
6
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2
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Happiness
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15
Dispositional Negative Affect
women
men